OMEGA® 1984 COMPLETE TEMPERATURE MEASUREMENT HANDBOOK AND ENCYCLOPEDIA™

88.1
OMEGA 871 DIGITAL THERMOMETER
87 1
OMEGA 868 THERMOMETER
86.8
70.0
MODEL 700F
THERMISTOR THERMOMETER
OMEGA ENGINEERING INC. Stamford, CT. U.S.A.
450 C
OMEGA 450 AET
THERMOCOUPLE THERMOMETER TYPE E
HOLD
OFF
ON °F
ON °C
1°
0.1°
TEMPERATURE INDICATOR
OMEGASCOPE
999
OMEGA

OMEGA
ENGINEERING, INC.
An OMEGA Group Company

(203) 359-1660

FROM THE LIBRARY OF:

NEW DEVELOPMENTS

AC LINE MONITOR 47 To 1000 Hz
CALIBRATED RANGE 0 To 300 V ac
+115 V
OMEGA ENGINEERING MODEL 199G
SIGNAL MONITOR
INPUT RANGE 0 To 10 V
-88.3
OMEGA ENGINEERING MODEL 199E
RATE
SINE OR PULSE INPUT
+440
OMEGA ENGINEERING MODEL 199C
PANEL METER
CALIBRATED RANGE ±199.9 mV
-199.9 mV
OMEGA ENGINEERING MODEL 199F
RMS ac To 20 kHz
CALIBRATED RANGE 0 To 1,999 V
+224 V
OMEGA ENGINEERING MODEL 199H
CURRENT LOOP MONITOR
INPUT RANGE 4 To 20 mA
+704
OMEGA ENGINEERING MODEL 199D
RTD PLATINUM 100Ω α = .00385
CALIBRATED RANGE -170.0° To 199.9°C
+179.3 C
OMEGA ENGINEERING MODEL 199B
OMEGA 880 DIGITAL MULTIMETER
86.5
2000mA
1000V 20MΩ
200
20
10A
2
200mV
200 Ω
V
mA
kΩ
DCV 1000V MAX
ACV 750V MAX
DCA 10A MAX
ACA 10A MAX
Ω 300V MAX
OS-500
INFRARED TO mV CONVERTER
OMEGA An OMEGA WYTE BOX™ PRODUCT
42 H
OMEGA ENGINEERING, INC. STAMFORD, CONN.
%RH
TEMP
OMEGA

Process Monitors
199 Letter Series
page M-3

Integral Probe/Handle
Model HPS
page A-6

Infrared to mV Converter
OS-500
page C-26

Humidity/Temperature Hand Held Met
Model RH-10
page C-3

Fluidized Sand Baths
FSB Series
page K-3

Dual Thermometer Kit
WB-DTK-A
page R-39

Signal Conditioners
OM3 Series
page R-5

Analog/RS-232C Interface
WB-31
page R-18

Talking Monitor
SLCII
page R-23

Noncontact Temperature Probe
OS-600
page C-28

PROBE #1
67.5 F PRESENT
SINCE NOV 29 1992
67.5 F MAX
66.0 F MIN
PROBE #2
DIFFERENCE (PROBE
DUAL THERMOMETER
OMEGA ENGINEERING, INC.
WB-31
WHITE BOX
OMEGA
ANALOG/RS-232C INTERFACE
OMEGA
TAC-386
OMEGA
OMX-1301
POWER SUPPLY
OM3
02-23
15:21:26
VOLUME
RESET
SLC II
OMEGA
OMEGA

1984 TEMPERATURE MEASUREMENT HANDBOOK AND ENCYCLOPEDIA™

CONTENTS

Ⓐ Thermocouple Probes and Assemblies
Ⓑ Industrial Thermocouple Assemblies
Ⓒ Infrared and Hand Held Instruments
Ⓓ Hand Held and Surface Thermocouple Probes
Ⓔ RTD Probes and Assemblies
Ⓕ Thermistor Probes and Assemblies
Ⓖ Connector Systems and Panels
Ⓗ Wire: Thermocouple, RTD and Thermistor
Ⓙ Cements, Coatings and Kits
Ⓚ Calibrators and Ice Point References
Ⓛ Analog Meters and Amplifiers
Ⓜ Digital Thermometers
Ⓝ Recorders
Ⓟ Solid State Controllers and Relays
Ⓠ Temperature Sensitive Products
Ⓡ Data Acquisition and Data Loggers
Ⓢ Dial Thermometers
Ⓣ Technical Books and Reference Section

The 1984 OMEGA Temperature Measurement Handbook has been designed to make it easy for you to locate the products you need for temperature measurement and control.

The column to the right symbolically depicts each section with a color panel matching a color strip on the edge of each page in a particular section. Simply fold back slightly, and match up the color to put you instantly into the section you want.

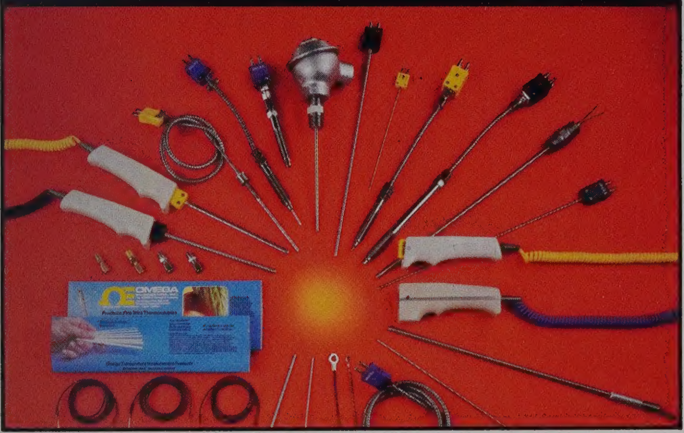
Immediately following, on pages 3 through 6, is a pictorial index showing many of the products in each section. Each individual section also has a graphic cover page to help locate a particular product in the section.

It is **OMEGA's** intention to place at the fingertips of industry and science the very latest and most pertinent temperature measurement and thermocouple alloy data. With this in mind SECTION T has been compiled with the latest, most comprehensive technical information. It contains the very latest Reference Tables for Thermocouples made available to **OMEGA** by the National Bureau of Standards. Included are the tables for Tungsten-Rhenium Alloy thermocouples as well as Platinum RTD elements as specified by DIN 43760.

For a more detailed listing of products in the Handbook, refer to the index.

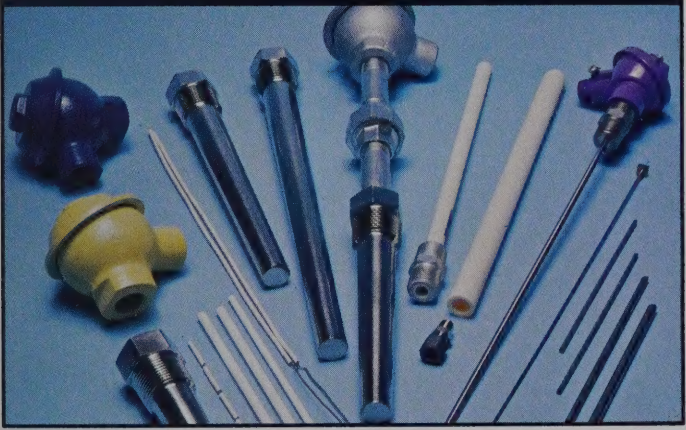
A

Thermocouple Probes and Assemblies



B

Industrial Thermocouple Assemblies



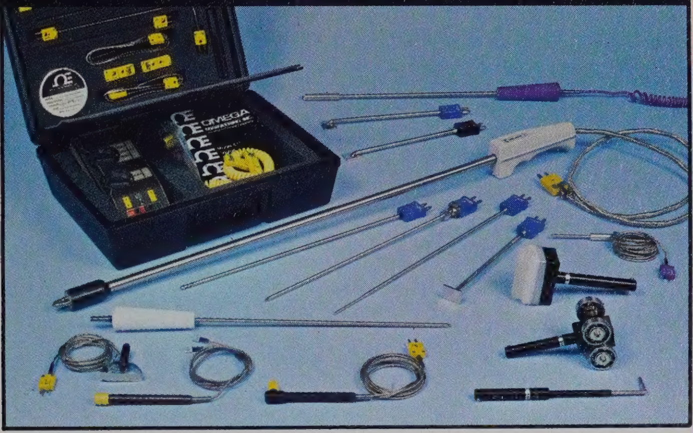
C

Infrared and Hand Held Instruments

BAT. LOW
70.0
450 °C
+32°F to +199°F
OFF
-22°F to +122°F
MODEL 700F
OMEGA
450 AET
THERMOCOUPLE THERMOMETER TYPE E

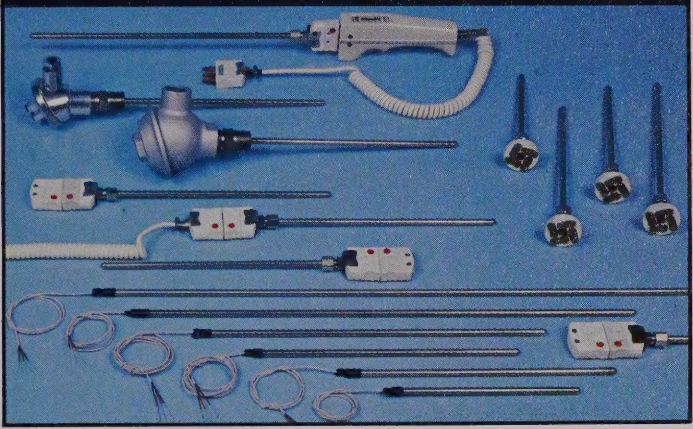
D

Hand Held and Surface Thermocouple Probes



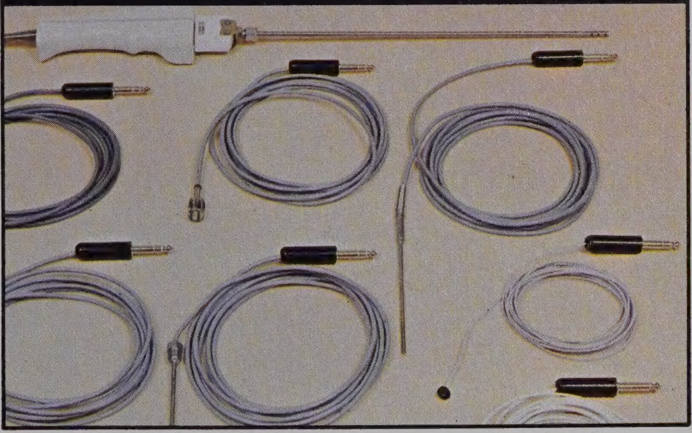
E

RTD Probes and Assemblies



F

Thermistor Probes and Assemblies



A
B
C
D
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G
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J
K
L
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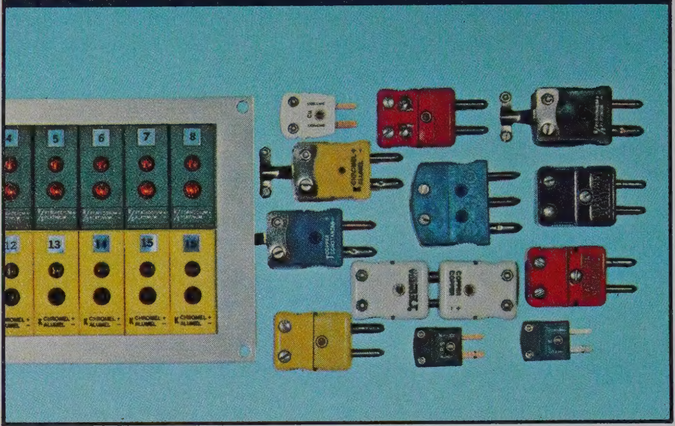
Q
R
S
T

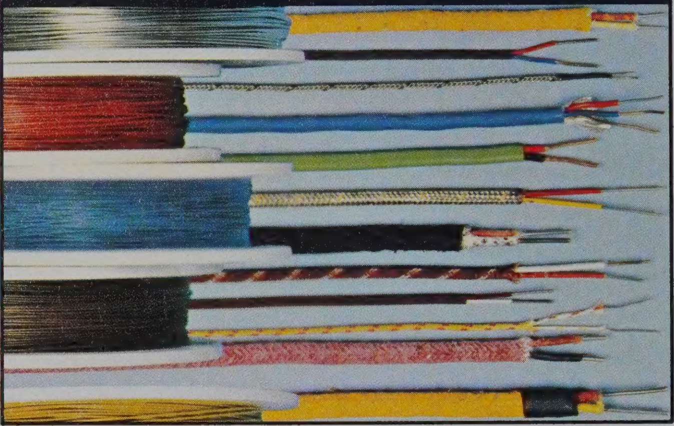
G

Connector Systems and Panels


4
5
6
7
8
12
13
14
15
16
CHROMEL + ALUMEL

H

Wire: Thermocouple, RTD and Thermistor



J

Cements, Coatings and Kits

K

Calibrators and Ice Point References

THERMOCOUPLE THERMOMETER
115F
115C
+ 8.10
OMEGA
TX53
TX58
TX 52

L

Analog Meters and Amplifiers

4660
5050
ice point cell
OMEGA
06503

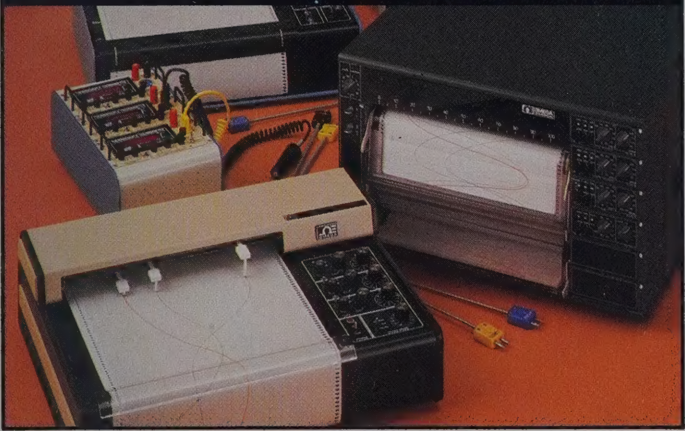
M

Digital Thermometers

19.3
NGINEERING
99C
RANGE
0 mA
RTD
PLATINUM 100Ω
α = .00385
CALIBRATED RANGE
-170.0° To 199.9°C
+440 °C
OMEGA ENGINEERING
MODEL 199B

N

Recorders



R

Data Acquisition and Data Loggers

μMEGA
OMEGA

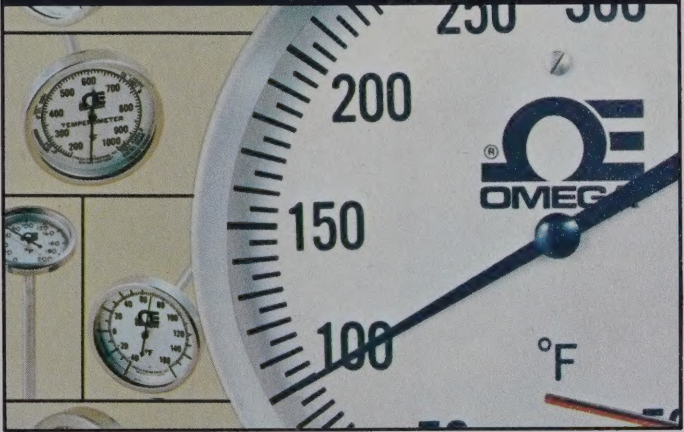
P

Solid State Controllers and Relays

OMEGA
99.9
450
780

S

Dial Thermometers


250
300
200
150
100
°F
OMEGA
TEMPERATURE

Q

Temperature Sensitive Products

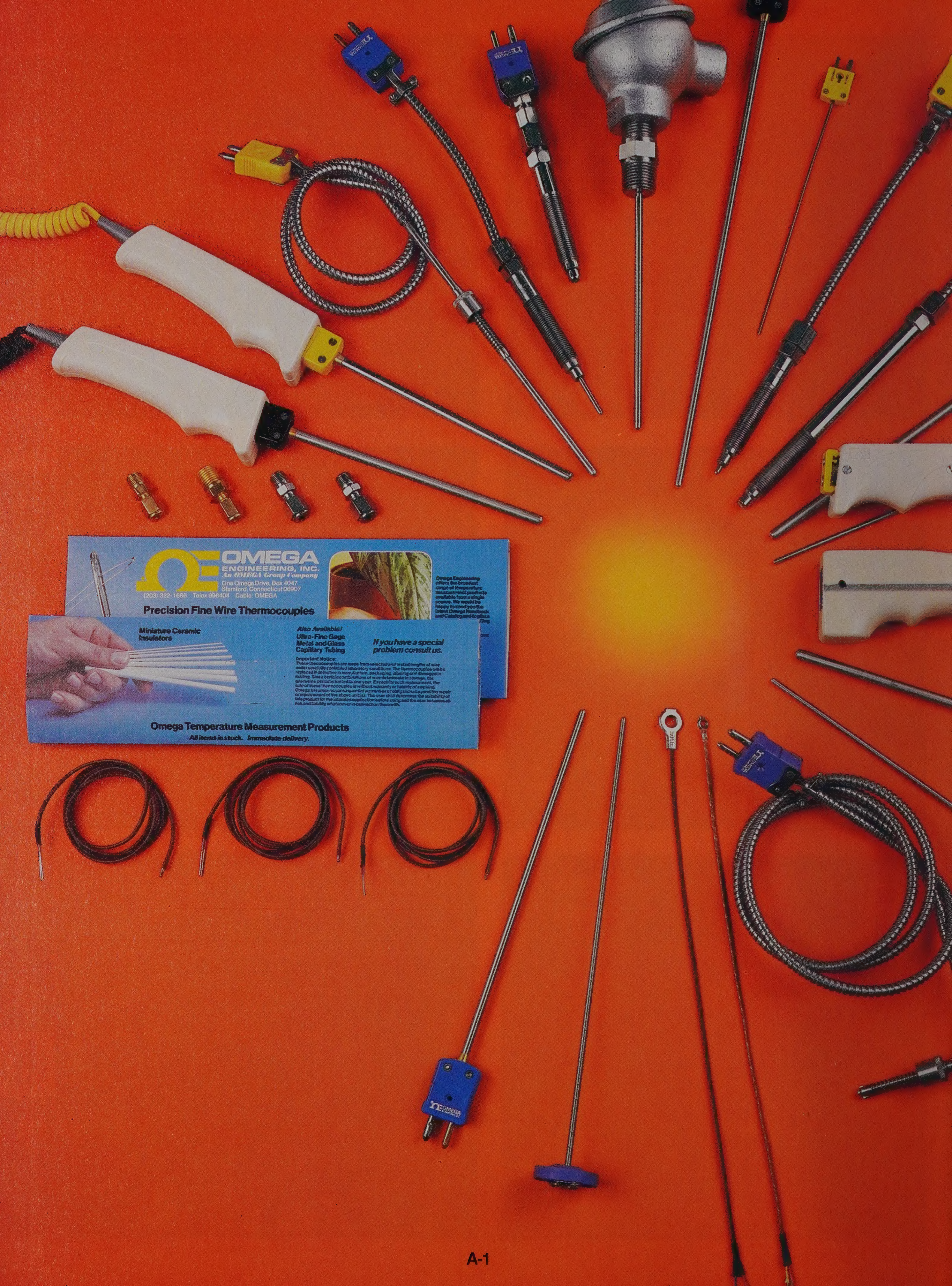
OMEGA TEST KIT
MELTING POINT STANDARDS
OMEGA

T

Technical Books and Reference Section

THERMOCOUPLE REFERENCE TABLES
OMEGA
999
°F
°C

A
B
C
D
E
F
G
H
J
K
L
M
N
P
Q
R
S
T



OMEGA ENGINEERING, INC.
An OMEGA Group Company
One Omega Drive, Box 4047
Stamford, Connecticut 06907
(203) 322-1666 Telex 996404 Cable: OMEGA

Precision Fine Wire Thermocouples

Omega Engineering offers the broadest range of temperature measurement products available from a single source. We would be happy to send you the latest Omega Handbook and Catalog and to place

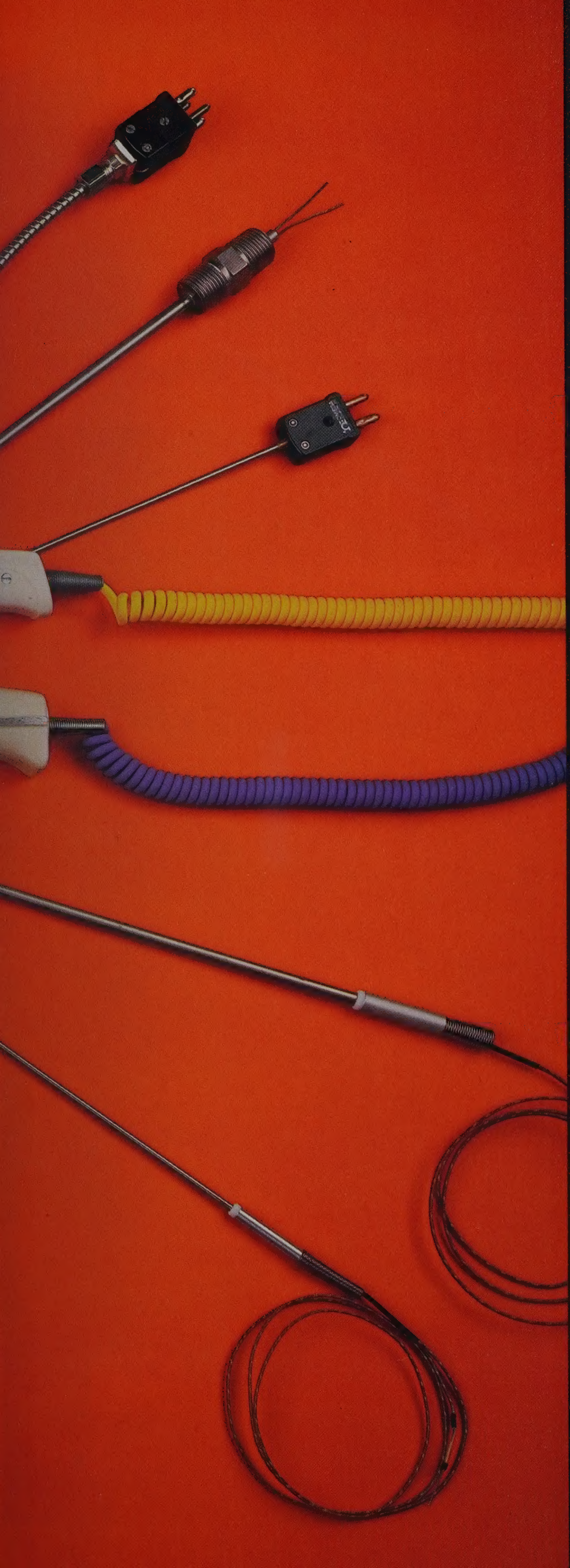
Miniature Ceramic Insulators

Also Available!
Ultra-Fine Gage Metal and Glass Capillary Tubing

If you have a special problem consult us.

Important Notice:
These thermocouples are made from selected and tested lengths of wire under carefully controlled laboratory conditions. The thermocouples will be replaced if defective in manufacture, packaging, labeling or if damaged in mailing. Since certain combinations of wire deteriorate in storage, the guarantee period is limited to one year. Except for such replacement, the sale of these thermocouples is without warranty or liability of any kind. Omega assumes no consequential warranties or obligations beyond the repair or replacement of the above unit(s). The user shall determine the suitability of this product for the intended application before using and the user assumes all risk and liability whatsoever in connection therewith.

Omega Temperature Measurement Products
All items in stock. Immediate delivery.



A

Thermocouple Probes and Assemblies

Probe/Handle combinations with custom measurement tips NEW	A-3
Integral Handle Probes NEW	A-5
Transition Joint Probes NEW	A-7
Quick Disconnect Probes	A-9
Subminiature Probes	A-10
Terminal Block Probes	A-11
Compression Fittings and Reducing Bushings	A-12
Very High Temperature Exotic Probes NEW	A-13
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Probes for Plastic Extruders	A-30

Quick Disconnect Handle/

High Impact Plastic Handle Style SDX

General Purpose Probe
$27
Sold separately.
See page A-9.

SDX Handle
$25
Sold separately.
See page G-5.

Order a Complete Handle and Probe Combination! SAVE $10

- 6 Custom Measuring Tips Available
- Choice of 2 Handle Styles
- Complete Probe Interchangeability
- Compatible with Hand Held Instruments
- 1 foot Retractable Cord

How to Order

High Impact Plastic Handle
SDX-SET-1-2-3

Rugged Aluminum Handle
HDX-SET-1-2-3

Ordering a Probe/Handle Set is as easy as 1, 2, 3.

1. Specify one of the six probe styles shown.
2. Specify thermocouple calibration J, K, T, E.
3. Specify the desired connector on the cord end.

Note:
Probe style determines the handle connector. Standard QD probes have OST connectors. Subminiature probes have SMP subminiature connectors. For special applications, grounded probes are available with the HDX handle (not available with air and subminiature probes). To order, specify "OTP" termination for the cord connector. 5 ft. of metal overbraided thermocouple wire will be supplied instead of the retractable cord; **Add $10** to the kit price.

Pricing:
The price of the set is determined by the probe style selected. Set prices are shown with the probe styles. For probes with 3-pin connectors and true grounding: **Add $10.** For the bent surface probe style shown on page A-5, specify "SP-60° bend"; **Add $6.**

J	Iron-Constantan	T	Copper-Constantan
K	Chromel-Alumel	E	Chromel-Constantan

See Section D for more probes!

Probe Sets

Rugged Aluminum Handle Style HDX

Quick Disconnect Probes for Handle Sets

GP

General Purpose
Our most popular style

SDX	HDX
$42	$47

12" Length; 1/8" O.D. Stainless Steel Sheath

NP

Penetration Style

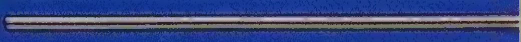
SDX	HDX
$55	$60

12" Length 3/16" O.D. Conical Point

RT

Fast Response Style

SDX	HDX
$60	$65

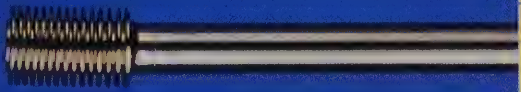


12" Length; Reduced to 1/16" O.D.

SP

Surface Probe

SDX	HDX
$100	$105



Flexible Tip

AP

Air Probe

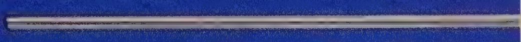
SDX	HDX
$95	$100

12" Length 3/16" O.D. Radiant Energy Shield

SM

Subminiature

SDX	HDX
$43	$48



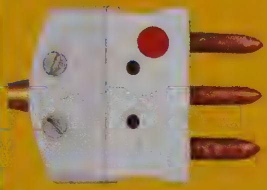
6" Length; 1/32" O.D. Stainless Steel Sheath

See page D-6 for information on standard size probes with custom measurement tips.

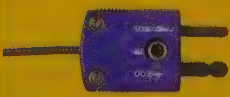
3 Connector Styles

K CHROMEL +
ALUMEL −

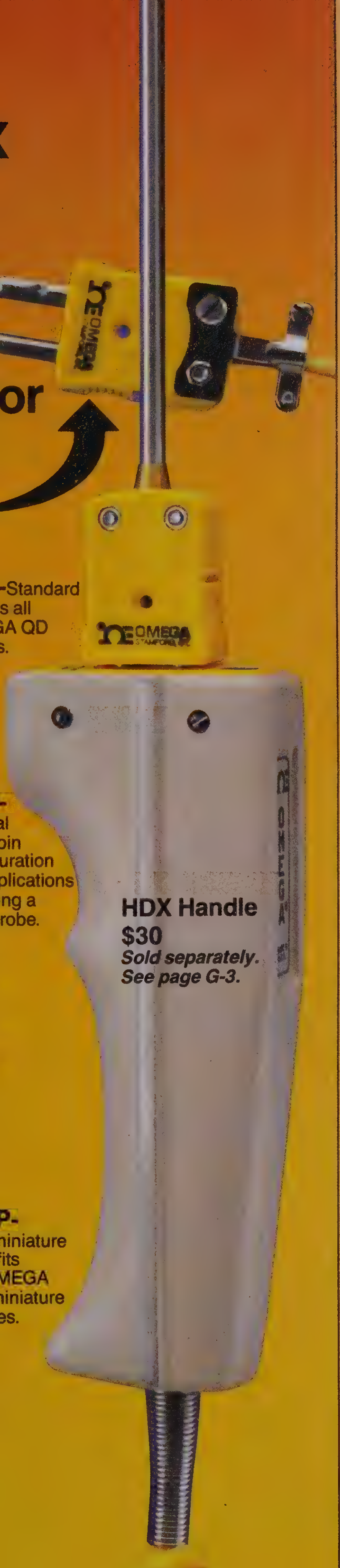
OST-Standard size fits all OMEGA QD probes.



OTP- Special three pin configuration for applications requiring a truly grounded probe.



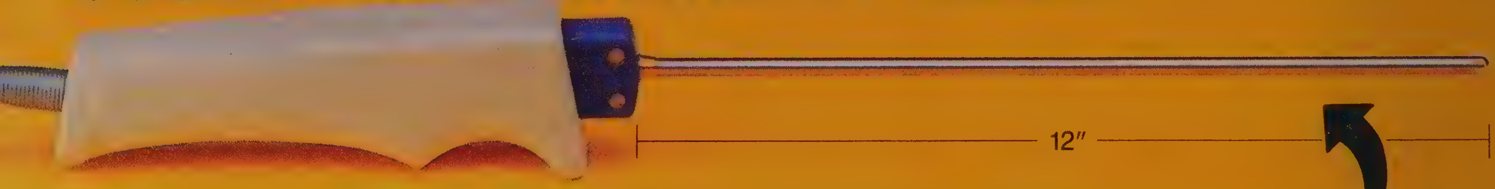
SMP- Subminiature size fits all OMEGA subminiature probes.



HDX Handle
$30
Sold separately.
See page G-3.

Integral Handle Probes **NEW!**

Custom Measurement Probes



Completely assembled with 1 ft. retractable cable (stretches to 5 ft.) and stripped end termination.

General Purpose Probe

1/8″ O.D. **$32**

Price includes probe with handle

Tip used for air and liquid immersion measurements. Made from rugged 304 stainless steel. Can be used for most heavy duty applications. Tip rated to 1700°F (927°C).

See page A-6 for the complete selection.

Penetration Probe

HPS-NP-[*]-316G-12

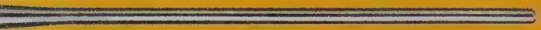
3/16″ O.D. **$45**

Price includes probe with handle

Tip designed for easy penetration into soft and semi-frozen objects. Made from rugged 304 stainless steel. Tip rated to 1700°F (927°C).

Fast Response Probe

HPS-RT-[*]-18G-12



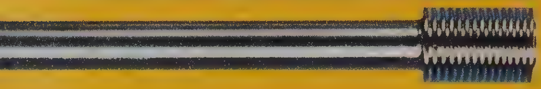
Reduced to 1/16″ O.D. **$50**

Price includes probe with handle

Special small diameter (1/16″) tip designed for fast response. Made from 304 stainless steel. Tip rated to 1700°F (927°C).

Surface Probe

HPS-SP-[*]-316G-12



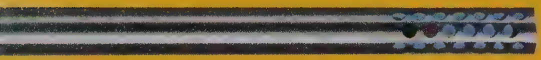
3/16″ O.D. **$90**

Price includes probe with handle

Flexible tip which conforms to most surfaces for fast, repeatable, accurate measurements. Made from rugged 304 stainless steel. Tip rated to 500°F (260°C).

Air Probe

HPS-AP-[*]-316E-12

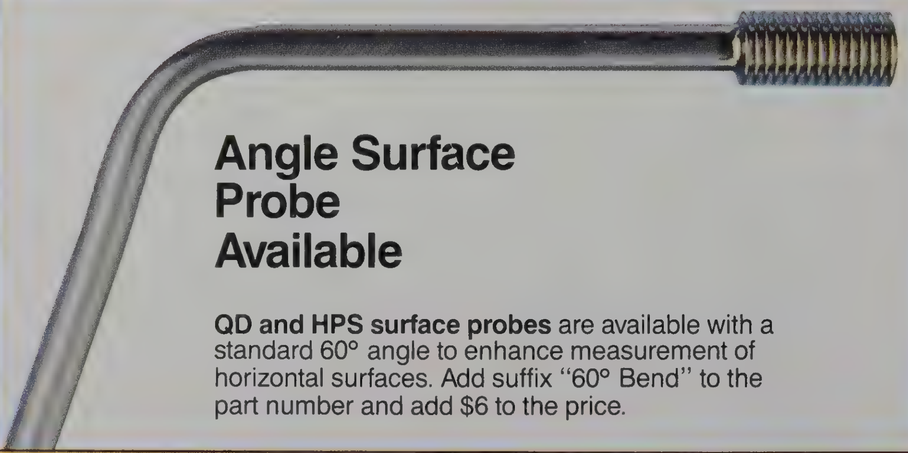


3/16″ O.D. **$85**

Price includes probe with handle

Radiant energy shield with fine gage wire thermocouple and 304 stainless steel sheath. Thermocouple tip is exposed to air flow for fast measurements and the constant diameter design facilitates easy insertion into duct work, grills and air vents. Tip rated to 500°F (260°C).

** Insert thermocouple type J, K, T, E*



Angle Surface Probe Available

QD and HPS surface probes are available with a standard 60° angle to enhance measurement of horizontal surfaces. Add suffix "60° Bend" to the part number and add $6 to the price.

Custom Assemblies Available

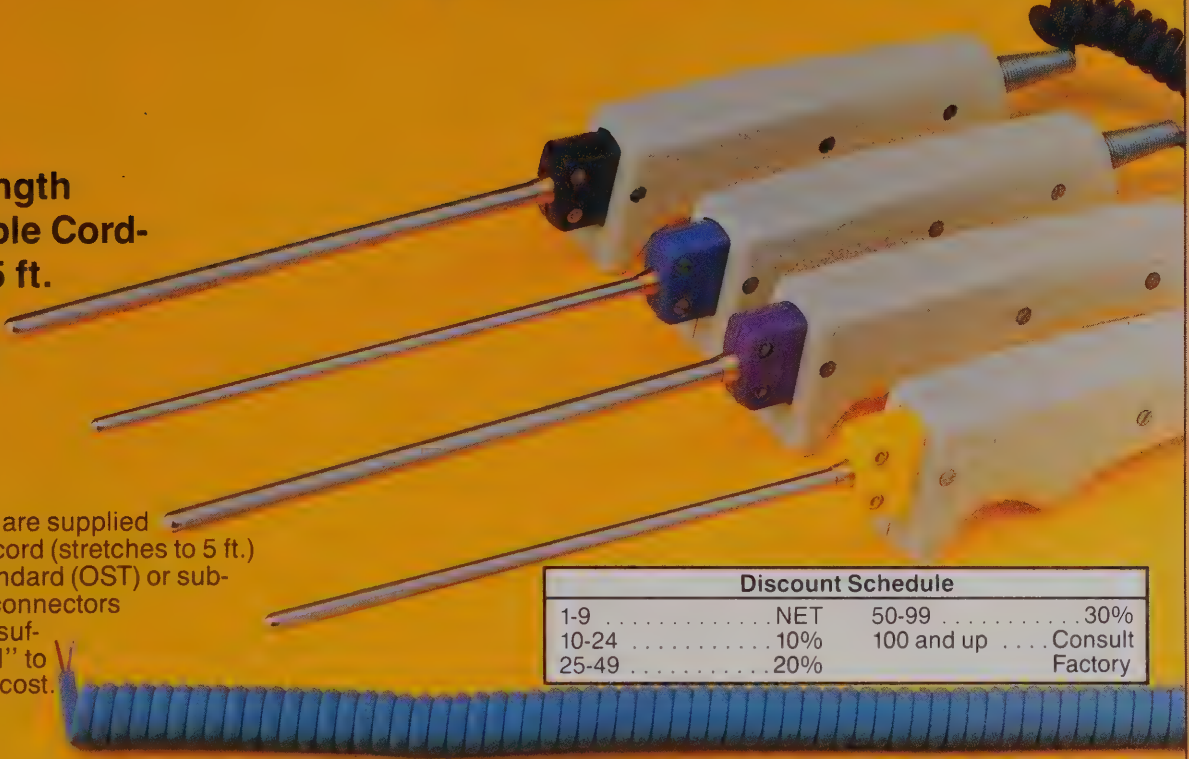
Thermocouple probes with integral high impact plastic handles, with 1 ft. retractable cord with stripped leads (other terminations are available). Handles are rated to 300°F.

Probes shown are available in J, K, T and E calibrations. Other sheath and lead lengths are available. Consult Sales Department for details.

NEW! Integral Handle Probes

High Impact Plastic Handle

- Heavy Duty
- 12″ Probe Length
- 1 ft. Retractable Cord-Stretches to 5 ft.
- Color-Coded
- Handle Rated to 300°F



Integral Handle probes are supplied with 1 ft. of retractable cord (stretches to 5 ft.) with stripped ends. Standard (OST) or sub-miniature (SMP) male connectors are also available. Add suffix "OST-M" or "SMP-M" to part number. Add $5 to cost.

Discount Schedule

1-9	NET	50-99	30%
10-24	10%	100 and up	Consult Factory
25-49	20%		

NOW WITH RETRACTABLE CABLE

In Stock for Immediate Delivery

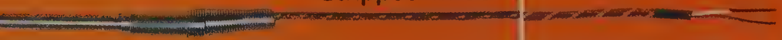
	SHEATH DIAMETER (IN.)	GROUNDED	PRICE	UNGROUNDED	PRICE	EXPOSED	PRICE	PRICE PER ADD'L FT. OF PROBE
IRON CONSTANTAN with INCONEL SHEATH	1/16	HPS-ICIN-116G-12	$32	HPS-ICIN-116U-12	$34	HPS-ICIN-116E-12	$32	$1.25
	1/8	HPS-ICIN-18G-12	32	HPS-ICIN-18U-12	34	HPS-ICIN-18E-12	32	2.50
	3/16	HPS-ICIN-316G-12	33	HPS-ICIN-316U-12	35	HPS-ICIN-316E-12	33	3.50
	1/4	HPS-ICIN-14G-12	36	HPS-ICIN-14U-12	38	HPS-ICIN-14E-12	36	6.00
IRON CONSTANTAN with 304 S.S. SHEATH	1/16	HPS-ICSS-116G-12	32	HPS-ICSS-116U-12	34	HPS-ICSS-116E-12	32	1.25
	1/8	HPS-ICSS-18G-12	32	HPS-ICSS-18U-12	34	HPS-ICSS-18E-12	32	1.50
	3/16	HPS-ICSS-316G-12	33	HPS-ICSS-316U-12	35	HPS-ICSS-316E-12	33	2.50
	1/4	HPS-ICSS-14G-12	36	HPS-ICSS-14U-12	38	HPS-ICSS-14E-12	36	4.00
CHROMEL ALUMEL with INCONEL SHEATH	1/16	HPS-CAIN-116G-12	32	HPS-CAIN-116U-12	34	HPS-CAIN-116E-12	32	1.25
	1/8	HPS-CAIN-18G-12	32	HPS-CAIN-18U-12	34	HPS-CAIN-18E-12	32	2.50
	3/16	HPS-CAIN-316G-12	33	HPS-CAIN-316U-12	35	HPS-CAIN-316E-12	33	3.50
	1/4	HPS-CAIN-14G-12	36	HPS-CAIN-14U-12	38	HPS-CAIN-14E-12	36	6.00
CHROMEL ALUMEL with 304 S.S. SHEATH	1/16	HPS-CASS-116G-12	32	HPS-CASS-116U-12	34	HPS-CASS-116E-12	32	1.25
	1/8	HPS-CASS-18G-12	32	HPS-CASS-18U-12	34	HPS-CASS-18E-12	32	1.50
	3/16	HPS-CASS-316G-12	33	HPS-CASS-316U-12	35	HPS-CASS-316E-12	33	2.50
	1/4	HPS-CASS-14G-12	36	HPS-CASS-14U-12	38	HPS-CASS-14E-12	36	4.00
CHROMEL CONSTANTAN with INCONEL SHEATH	1/16	HPS-CXIN-116G-12	32	HPS-CXIN-116U-12	34	HPS-CXIN-116E-12	32	1.50
	1/8	HPS-CXIN-18G-12	32	HPS-CXIN-18U-12	34	HPS-CXIN-18E-12	32	3.00
	3/16	HPS-CXIN-316G-12	33	HPS-CXIN-316U-12	35	HPS-CXIN-316E-12	33	4.00
	1/4	HPS-CXIN-14G-12	40	HPS-CXIN-14U-12	42	HPS-CXIN-14E-12	40	6.00
CHROMEL CONSTANTAN with 304 S.S. SHEATH	1/16	HPS-CXSS-116G-12	32	HPS-CXSS-116U-12	34	HPS-CXSS-116E-12	32	1.25
	1/8	HPS-CXSS-18G-12	32	HPS-CXSS-18U-12	34	HPS-CXSS-18E-12	32	2.00
	3/16	HPS-CXSS-316G-12	33	HPS-CXSS-316U-12	35	HPS-CXSS-316E-12	33	2.50
	1/4	HPS-CXSS-14G-12	36	HPS-CXSS-14U-12	38	HPS-CXSS-14E-12	36	4.00
COPPER CONSTANTAN with INCONEL SHEATH	1/16	HPS-CPIN-116G-12	32	HPS-CPIN-116U-12	34	HPS-CPIN-116E-12	32	1.50
	1/8	HPS-CPIN-18G-12	32	HPS-CPIN-18U-12	34	HPS-CPIN-18E-12	32	3.00
	3/16	HPS-CPIN-316G-12	33	HPS-CPIN-316U-12	35	HPS-CPIN-316E-12	33	4.00
	1/4	HPS-CPIN-14G-12	40	HPS-CPIN-14U-12	42	HPS-CPIN-14E-12	40	6.00
COPPER CONSTANTAN with 304 S.S. SHEATH	1/16	HPS-CPSS-116G-12	32	HPS-CPSS-116U-12	34	HPS-CPSS-116E-12	32	1.25
	1/8	HPS-CPSS-18G-12	32	HPS-CPSS-18U-12	34	HPS-CPSS-18E-12	32	2.00
	3/16	HPS-CPSS-316G-12	33	HPS-CPSS-316U-12	35	HPS-CPSS-316E-12	33	2.50
	1/4	HPS-CPSS-14G-12	36	HPS-CPSS-14U-12	38	HPS-CPSS-14E-12	36	4.00

Price includes probe with handle

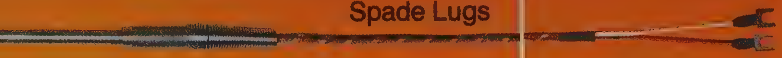
Probe Lead Configurations

STANDARD TJ PROBE

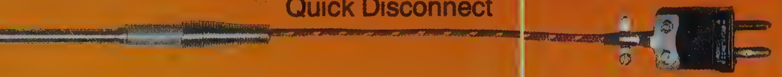
Stripped Ends



Spade Lugs



Quick Disconnect



OST-M

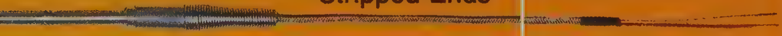
Standard TJ probe construction shown. No suffix is necessary.

Standard TJ probe construction with thermocouple alloy compensated spade lugs attached. Add suffix LUG and $3 to the standard price.

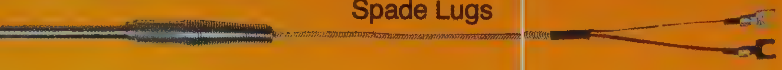
Standard TJ probe construction with OST or SMP male thermocouple connector attached. Add suffix OST-M or SMP-M and $5 to the standard price.

STAINLESS STEEL OVERBRAIDING

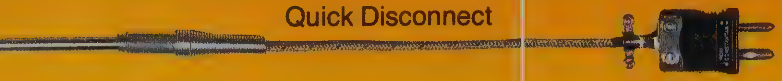
Stripped Ends



Spade Lugs



Quick Disconnect



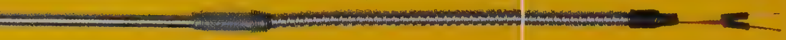
Standard TJ probe construction with stainless steel overbraided lead wire. Add suffix SB and $3 to standard price.

Standard TJ probe construction with stainless steel overbraided lead wire and thermocouple alloy compensated spade lugs. Add suffix SB-LUG and $6 to the standard price.

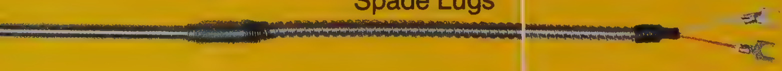
Standard TJ probe with stainless steel overbraided lead wire and OST or SMP male connector. Add suffix SB-OST-M or SB-SMP-M and $8 to the standard price.

ARMORED CABLE

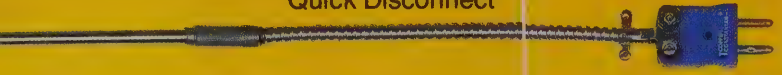
Stripped Ends



Spade Lugs



Quick Disconnect

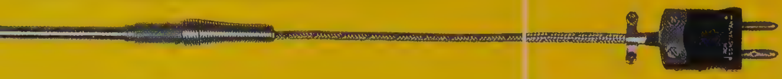


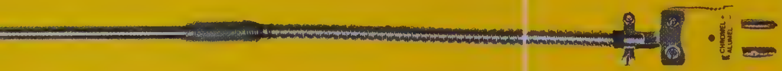
Standard TJ probe construction with spiral armor cable. Add suffix BX and $5 to standard price.

Standard TJ probe construction with spiral armor cable and thermocouple alloy compensated spade lugs. Add suffix BX-LUG and $8 to the standard price.

Standard TJ probe with spiral armor cable and OST male connector. Add suffix BX-OST-M and $10 to the standard price.

HIGH TEMPERATURE STAINLESS STEEL OVERBRAIDING

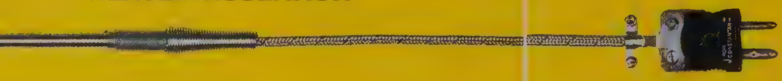


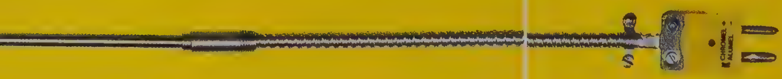


HIGH TEMPERATURE TJ PROBES 900°F

Available in the same terminations shown above but with high temperature construction. Entire probe will withstand 900°F (482°C). Add suffix CC to suffixes used above and $10 additional to price of probe.

ULTRA-HIGH TEMPERATURE NEXTEL INSULATION





ULTRA-HIGH TEMPERATURE TJ PROBES 1500°F

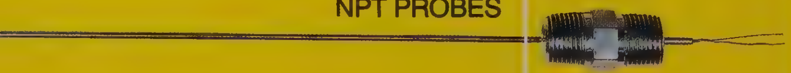
Available in the same terminations shown above. Special high temperature construction with Nextel ceramic fiber insulation and Inconel overbraiding or SS armor for a temperature rating of 1500°F (815°C). Add suffix CC-XCIB or CC-XCBX to above numbers and $17 additional to price of probe.

REPLACEMENT PROBES

RP

RP-BB

NPT PROBES

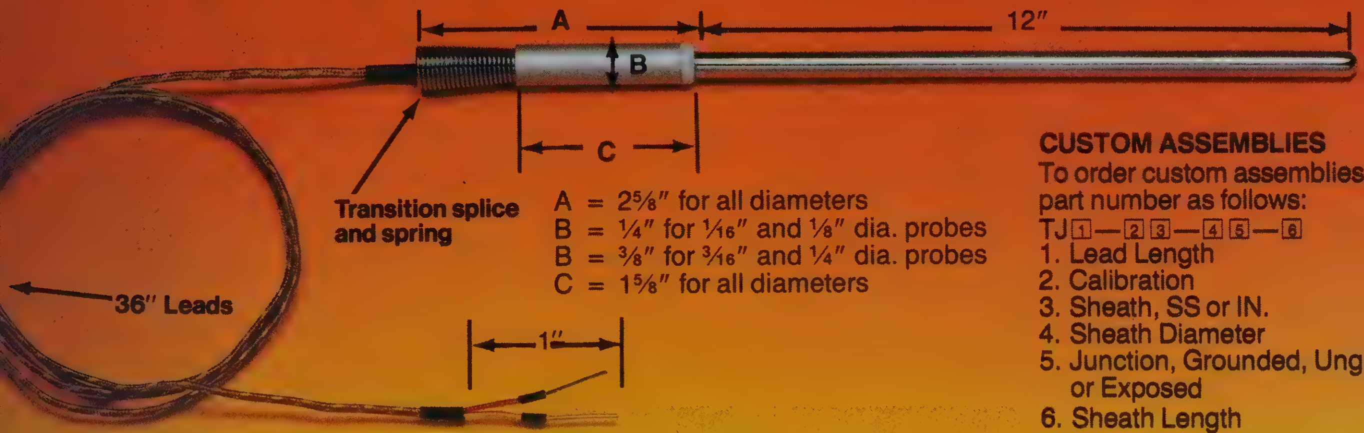


REPLACEMENT PROBES

Thermocouple probes can be supplied with no leads by requesting replacement probes. Add suffix RP to the part number and deduct $5 from the standard QD price.

Thermocouple probes can also be supplied with a brass block for mounting into connectors or fittings. Add suffix RP-BB to the part number and deduct $2 from the standard QD price.

Thermocouple Assemblies with OMEGA Heavy Duty Transition Joints



A = 2⅝″ for all diameters
B = ¼″ for ⅟₁₆″ and ⅛″ dia. probes
B = ⅜″ for ³⁄₁₆″ and ¼″ dia. probes
C = 1⅝″ for all diameters

CUSTOM ASSEMBLIES

To order custom assemblies specify part number as follows:

TJ1—23—45—6

1. Lead Length
2. Calibration
3. Sheath, SS or IN.
4. Sheath Diameter
5. Junction, Grounded, Ungrounded or Exposed
6. Sheath Length

PRICE LIST

Standard sizes **in stock** for immediate delivery.

	SHEATH* DIAMETER (IN.)	GROUNDED	PRICE	UNGROUNDED	PRICE	EXPOSED	PRICE	PRICE PER ADD'L FT.
IRON CONSTANTAN with INCONEL SHEATH	1/16	TJ36-ICIN-116G-12	$28	TJ36-ICIN-116U-12	$30	TJ36-ICIN-116E-12	$28	$1.25
	1/8	TJ36-ICIN-18G-12	28	TJ36-ICIN-18U-12	30	TJ36-ICIN-18E-12	28	2.50
	3/16	TJ36-ICIN-316G-12	29	TJ36-ICIN-316U-12	31	TJ36-ICIN-316E-12	29	3.50
	1/4	TJ36-ICIN-14G-12	35	TJ36-ICIN-14U-12	37	TJ36-ICIN-14E-12	35	6.00
IRON CONSTANTAN with 304 S.S. SHEATH	1/16	TJ36-ICSS-116G-12	$28	TJ36-ICSS-116U-12	$30	TJ36-ICSS-116E-12	$28	$1.25
	1/8	TJ36-ICSS-18G-12	28	TJ36-ICSS-18U-12	30	TJ36-ICSS-18E-12	28	1.50
	3/16	TJ36-ICSS-316G-12	29	TJ36-ICSS-316U-12	31	TJ36-ICSS-316E-12	29	2.50
	1/4	TJ36-ICSS-14G-12	35	TJ36-ICSS-14U-12	37	TJ36-ICSS-14E-12	35	4.00
CHROMEL ALUMEL with INCONEL SHEATH	1/16	TJ36-CAIN-116G-12	$28	TJ36-CAIN-116U-12	$30	TJ36-CAIN-116E-12	$28	$1.25
	1/8	TJ36-CAIN-18G-12	28	TJ36-CAIN-18U-12	30	TJ36-CAIN-18E-12	28	2.50
	3/16	TJ36-CAIN-316G-12	29	TJ36-CAIN-316U-12	31	TJ36-CAIN-316E-12	29	3.50
	1/4	TJ36-CAIN-14G-12	35	TJ36-CAIN-14U-12	37	TJ36-CAIN-14E-12	35	6.00
CHROMEL ALUMEL with 304 S.S. SHEATH	1/16	TJ36-CASS-116G-12	$28	TJ36-CASS-116U-12	$30	TJ36-CASS-116E-12	$28	$1.25
	1/8	TJ36-CASS-18G-12	28	TJ36-CASS-18U-12	30	TJ36-CASS-18E-12	28	1.50
	3/16	TJ36-CASS-316G-12	29	TJ36-CASS-316U-12	31	TJ36-CASS-316E-12	29	2.50
	1/4	TJ36-CASS-14G-12	35	TJ36-CASS-14U-12	37	TJ36-CASS-14E-12	35	4.00
CHROMEL CONSTANTAN with INCONEL SHEATH	1/16	TJ36-CXIN-116G-12	$28	TJ36-CXIN-116U-12	$30	TJ36-CXIN-116E-12	$28	$1.50
	1/8	TJ36-CXIN-18G-12	28	TJ36-CXIN-18U-12	30	TJ36-CXIN-18E-12	28	3.00
	3/16	TJ36-CXIN-316G-12	29	TJ36-CXIN-316U-12	31	TJ36-CXIN-316E-12	29	4.00
	1/4	TJ36-CXIN-14G-12	36	TJ36-CXIN-14U-12	38	TJ36-CXIN-14E-12	36	6.00
CHROMEL CONSTANTAN with 304 S.S. SHEATH	1/16	TJ36-CXSS-116G-12	$28	TJ36-CXSS-116U-12	$30	TJ36-CXSS-116E-12	$28	$1.25
	1/8	TJ36-CXSS-18G-12	28	TJ36-CXSS-18U-12	30	TJ36-CXSS-18E-12	28	2.00
	3/16	TJ36-CXSS-316G-12	29	TJ36-CXSS-316U-12	31	TJ36-CXSS-316E-12	29	2.50
	1/4	TJ36-CXSS-14G-12	35	TJ36-CXSS-14U-12	37	TJ36-CXSS-14E-12	35	4.00
COPPER CONSTANTAN with INCONEL SHEATH	1/16	TJ36-CPIN-116G-12	$28	TJ36-CPIN-116U-12	$30	TJ36-CPIN-116E-12	$28	$1.50
	1/8	TJ36-CPIN-18G-12	28	TJ36-CPIN-18U-12	30	TJ36-CPIN-18E-12	28	3.00
	3/16	TJ36-CPIN-316G-12	29	TJ36-CPIN-316U-12	31	TJ36-CPIN-316E-12	29	4.00
	1/4	TJ36-CPIN-14G-12	36	TJ36-CPIN-14U-12	38	TJ36-CPIN-14E-12	36	6.00
COPPER CONSTANTAN with 304 S.S. SHEATH	1/16	TJ36-CPSS-116G-12	$28	TJ36-CPSS-116U-12	$30	TJ36-CPSS-116E-12	$28	$1.25
	1/8	TJ36-CPSS-18G-12	28	TJ36-CPSS-18U-12	30	TJ36-CPSS-18E-12	28	2.00
	3/16	TJ36-CPSS-316G-12	29	TJ36-CPSS-316U-12	31	TJ36-CPSS-316E-12	29	2.50
	1/4	TJ36-CPSS-14G-12	35	TJ36-CPSS-14U-12	37	TJ36-CPSS-14E-12	35	4.00

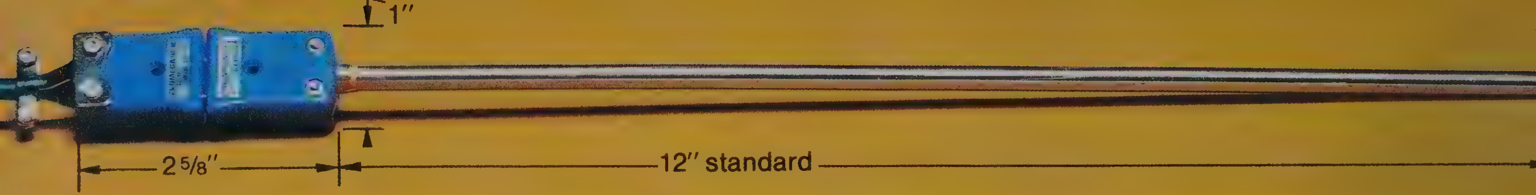
* SEE TABLE ON PAGE H-33 and H-34 FOR PROBE RESISTANCE VS. SHEATH DIAMETER AND LENGTH.

Dual Elements
Available only in ⅟₁₆ to ¼ inches. .040 diameter available upon request for TJ termination only.

Discount Schedule for Thermocouple Assemblies

1-9 units	Net	50-99 units	30%
10-24 units	10%	100 and up	Consult factory
25-49 units	20%		

Quantity discount applies to like probes. Other sizes, materials and configurations by quotation.



Quick Disconnect Thermocouple Assemblies

Price List: Prices given for 12 inch lengths (standard).

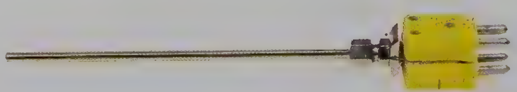
	SHEATH* DIAMETER (IN.)	GROUNDED*	PRICE	UNGROUNDED*	PRICE	EXPOSED*	PRICE	PRICE PER ADD'L FT.
IRON CONSTANTAN with INCONEL SHEATH	1/16	ICIN-116G-12	$27	ICIN-116U-12	$29	ICIN-116E-12	$27	$1.25
	1/8	ICIN-18G-12	27	ICIN-18U-12	29	ICIN-18E-12	27	2.50
	3/16	ICIN-316G-12	28	ICIN-316U-12	30	ICIN-316E-12	28	3.50
	1/4	ICIN-14G-12	31	ICIN-14U-12	33	ICIN-14E-12	31	6.00
IRON CONSTANTAN with 304 S.S. SHEATH	1/16	ICSS-116G-12	27	ICSS-116U-12	29	ICSS-116E-12	27	1.25
	1/8	ICSS-18G-12	27	ICSS-18U-12	29	ICSS-18E-12	27	1.50
	3/16	ICSS-316G-12	28	ICSS-316U-12	30	ICSS-316E-12	28	2.50
	1/4	ICSS-14G-12	31	ICSS-14U-12	33	ICSS-14E-12	31	4.00
CHROMEL ALUMEL with INCONEL SHEATH	1/16	CAIN-116G-12	27	CAIN-116U-12	29	CAIN-116E-12	27	1.25
	1/8	CAIN-18G-12	27	CAIN-18U-12	29	CAIN-18E-12	27	2.50
	3/16	CAIN-316G-12	28	CAIN-316U-12	30	CAIN-316E-12	28	3.50
	1/4	CAIN-14G-12	31	CAIN-14U-12	33	CAIN-14E-12	31	6.00
CHROMEL ALUMEL with 304 S.S. SHEATH	1/16	CASS-116G-12	27	CASS-116U-12	29	CASS-116E-12	27	1.25
	1/8	CASS-18G-12	27	CASS-18U-12	29	CASS-18E-12	27	1.50
	3/16	CASS-316G-12	28	CASS-316U-12	30	CASS-316E-12	28	2.50
	1/4	CASS-14G-12	31	CASS-14U-12	33	CASS-14E-12	31	4.00
CHROMEL CONSTANTAN with INCONEL SHEATH	1/16	CXIN-116G-12	27	CXIN-116U-12	29	CXIN-116E-12	27	1.50
	1/8	CXIN-18G-12	27	CXIN-18U-12	39	CXIN-18E-12	27	3.00
	3/16	CXIN-316G-12	28	CXIN-316U-12	30	CXIN-316E-12	28	4.00
	1/4	CXIN-14G-12	35	CXIN-14U-12	37	CXIN-14E-12	35	6.00
CHROMEL CONSTANTAN with 304 S.S. SHEATH	1/16	CXSS-116G-12	27	CXSS-116U-12	29	CXSS-116E-12	27	1.25
	1/8	CXSS-18G-12	27	CXSS-18U-12	29	CXSS-18E-12	27	2.00
	3/16	CXSS-316G-12	28	CXSS-316U-12	30	CXSS-316E-12	28	2.50
	1/4	CXSS-14G-12	31	CXSS-14U-12	33	CXSS-14E-12	31	4.00
COPPER CONSTANTAN with INCONEL SHEATH	1/16	CPIN-116G-12	27	CPIN-116U-12	29	CPIN-116E-12	27	1.50
	1/8	CPIN-18G-12	27	CPIN-18U-12	29	CPIN-18E-12	27	3.00
	3/16	CPIN-316G-12	28	CPIN-316U-12	30	CPIN-316E-12	28	4.00
	1/4	CPIN-14G-12	35	CPIN-14U-12	37	CPIN-14E-12	35	6.00
COPPER CONSTANTAN with 304 S.S. SHEATH	1/16	CPSS-116G-12	27	CPSS-116U-12	29	CPSS-116E-12	27	1.25
	1/8	CPSS-18G-12	27	CPSS-18U-12	29	CPSS-18E-12	27	2.00
	3/16	CPSS-316G-12	28	CPSS-316U-12	30	CPSS-316E-12	28	2.50
	1/4	CPSS-14G-12	31	CPSS-14U-12	33	CPSS-14E-12	31	4.00

PCLM supplied with all quick-disconnect thermocouple assemblies. ★ SEE TABLE ON PAGE H-33 and H-34 FOR PROBE RESISTANCE

*ALSO AVAILABLE!

Dual Element Probe—All styles, All sizes

Add (DUAL) after initial prefix in part number. Consult Sales Department for Price.



Example: ICIN (DUAL)-14G-12
Price: $64.50

Discount Schedule for Thermocouple Assemblies and Replacement Probes.

Probes:

1-9 units	Net
10-24 units	10%
25-49 units	20%
50-99 units	30%
100 and up	Consult factory

Quantity discount applies to like probes. Other sizes, materials and configurations by quotation.

Subminiature Thermocouple Probe Assemblies

with Heavy Duty Glass Filled Nylon Miniature Quick Disconnects

- Color Coded
- 0.010 to 0.125 Diameter
- Bendable to Twice the Diameter
- Stainless Steel and Inconel 600 Sheaths
- Mating Female Connector Included
- MgO Insulation
- Exposed, Grounded or Ungrounded

OMEGA
K
CHROMEL
ALUMEL
OMEGA
T
COPPER
CONST

Shown Larger Than Actual Size.

OFF-THE-SHELF DELIVERIES

THERMOCOUPLE ALLOY	*SHEATH DIA. [IN.]	GROUNDED JUNCTION	PRICE	UNGROUNDED JUNCTION	PRICE	EXPOSED JUNCTION	PRICE	PRICE PER ADD'L. 6"
IRON CONSTANTAN with 304 S.S. SHEATH*	0.010	SICSS-010G-6	$48	SICSS-010U-6	$68	SICSS-010E-6	$48	$1.00
	0.020	SICSS-020G-6	28	SICSS-020U-6	30	SICSS-020E-6	28	.50
	1/32	SICSS-032G-6	28	SICSS-032U-6	30	SICSS-032E-6	28	.50
	0.040	SICSS-040G-6	28	SICSS-040U-6	30	SICSS-040E-6	35	.50
	1/16	SICSS-062G-6	24	SICSS-062U-6	26	SICSS-062E-6	24	.63
	1/8	SICSS-125G-6	24	SICSS-125U-6	26	SICSS-125E-6	24	.75
CHROMEL ALUMEL with 304 S.S. SHEATH*	0.010	SCASS-010G-6	$48	SCASS-010U-6	$68	SCASS-010E-6	$48	$1.00
	0.020	SCASS-020G-6	28	SCASS-020U-6	30	SCASS-020E-6	28	.50
	1/32	SCASS-032G-6	28	SCASS-032U-6	30	SCASS-032E-6	28	.50
	0.040	SCASS-040G-6	28	SCASS-040U-6	30	SCASS-040E-6	35	.50
	1/16	SCASS-062G-6	24	SCASS-062U-6	26	SCASS-062E-6	24	.63
	1/8	SCASS-125G-6	24	SCASS-125U-6	26	SCASS-125E-6	24	.75
CHROMEL CONSTANTAN with 304 S.S. SHEATH*	0.010	SCXSS-010G-6	$48	SCXSS-010U-6	$68	SCXSS-010E-6	$48	$1.00
	0.020	SCXSS-020G-6	28	SCXSS-020U-6	30	SCXSS-020E-6	28	.50
	1/32	SCXSS-032G-6	28	SCXSS-032U-6	30	SCXSS-032E-6	28	.50
	0.040	SCXSS-040G-6	28	SCXSS-040U-6	30	SCXSS-040E-6	35	.50
	1/16	SCXSS-062G-6	24	SCXSS-062U-6	26	SCXSS-062E-6	24	.63
	1/8	SCXSS-125G-6	24	SCXSS-125U-6	26	SCXSS-125E-6	24	.75
COPPER CONSTANTAN with 304 S.S. SHEATH*	0.020	SCPSS-020G-6	$28	SCPSS-020U-6	$30	SCPSS-020E-6	$28	$ .50
	1/32	SCPSS-032G-6	28	SCPSS-032U-6	30	SCPSS-032E-6	28	.50
	0.040	SCPSS-040G-6	28	SCPSS-040U-6	30	SCPSS-040E-6	35	.50
	1/16	SCPSS-062G-6	24	SCPSS-062U-6	26	SCPSS-062E-6	24	.63
	1/8	SCPSS-125G-6	24	SCPSS-125U-6	26	SCPSS-125E-6	24	.75

Dual Elements are Not Available with SMP Probes

*TO ORDER INCONEL 600 SHEATH: Change "SS" in the part number to "IN". Price unchanged for standard lengths. Consult Sales Department for additional lengths.

TO ORDER REPLACEMENT PROBES: Add -RP to the part number. Deduct $1.

TO ORDER REPLACEMENT PROBES WITH BRASS BLOCKS: Add -RP-BB to the part number. Deduct $1.

(Brass block will be attached unless otherwise noted)

Discount Schedule

1 - 9 Probes	NET	50 - 99	30%
10 - 24	10%	100 and up	Consult Sales Department
25 - 49	20%		

Quantity discount applies to like probes.
Other sizes, materials and lengths by quotation.

Terminal Block Probes

- **Color Coded Terminal Block**
- **Single or Dual Element**
- **Quick Hook-up**
- **Terminal Block Rated to 425°F (218°C)**
- **In Stock with 12″ (304 mm) Length**

Probes can be used for direct immersion or can be mounted with an OMEGALOK™ compression fitting shown on page E-7. Terminal blocks are sold separately on page G-24.

Prices Start at $27

	Diameter	Grounded		Ungrounded		Exposed		Add'l Foot
Chromel-Alumel with 304 SS sheath	1/16″	TB-CASS-116G-12	$27	TB-CASS-116U-12	$29	TB-CASS-116E-12	$27	$1.25
	⅛	TB-CASS-18G-12	27	TB-CASS-180-12	29	TB-CASS-18E-12	27	1.50
	3/16	TB-CASS-316G-12	28	TB-CASS-3160-12	30	TB-CASS-316E-12	28	2.50
	¼	TB-CASS-14G-12	31	TB-CASS-14U-12	33	TB-CASS-14E-12	31	4.00
Chromel-Alumel with Inconel sheath	1/16″	TB-CAIN-116G-12	27	TB-CAIN-116U-12	29	TB-CAIN-116E-12	27	1.25
	⅛	TB-CAIN-18G-12	27	TB-CAIN-18U-12	29	TB-CAIN-18E-12	27	2.50
	3/16	TB-CAIN-316G-12	28	TB-CAIN-316U-12	30	TB-CAIN-316E-12	28	3.50
	¼	TB-CAIN-14G-12	31	TB-CAIN-14U-12	33	TB-CAIN-14E-12	31	6.00
Iron-Constantan with 304 SS sheath	1/16″	TB-ICSS-116G-12	27	TB-ICSS-116U-12	29	TB-ICSS-116E-12	27	1.25
	⅛	TB-ICSS-18G-12	27	TB-ICSS-18U-12	29	TB-ICSS-18E-12	27	1.50
	3/16	TB-ICSS-316G-12	28	TB-ICSS-316U-12	30	TB-ICSS-316E-12	28	2.50
	¼	TB-ICSS-14G-12	31	TB-ICSS-14U-12	33	TB-ICSS-14E-12	31	4.00
Iron-Constantan with Inconel sheath	1/16″	TB-ICIN-116G-12	27	TB-ICIN-116U-12	29	TB-ICIN-116E-12	27	1.25
	⅛	TB-ICIN-18G-12	27	TB-ICIN-18U-12	29	TB-ICIN-18E-12	27	2.50
	3/16	TB-ICIN-316G-12	28	TB-ICIN-316U-12	30	TB-ICIN-316E-12	28	3.50
	¼	TB-ICIN-14G-12	31	TB-ICIN-14U-12	33	TB-ICIN-14E-12	31	6.00
Chromel-Constantan with 304 SS sheath	1/16″	TB-CXSS-116G-12	27	TB-CXSS-116U-12	29	TB-CXSS-116E-12	27	1.25
	⅛	TB-CXSS-18G-12	27	TB-CXSS-18U-12	29	TB-CXSS-18E-12	27	2.00
	3/16	TB-CXSS-316G-12	28	TB-CXSS-316U-12	30	TB-CXSS-316E-12	28	2.50
	¼	TB-CXSS-14G-12	31	TB-CXSS-14U-12	33	TB-CXSS-14E-12	31	4.00
Chromel-Constantan with Inconel sheath	1/16″	TB-CXIN-116G-12	27	TB-CXIN-116U-12	29	TB-CXIN-116E-12	27	1.50
	⅛	TB-CXIN-18G-12	27	TB-CXIN-18U-12	29	TB-CXIN-18E-12	27	3.00
	3/16	TB-CXIN-316G-12	28	TB-CXIN-316U-12	30	TB-CXIN-316E-12	28	4.00
	¼	TB-CXIN-14G-12	35	TB-CXIN-14U-12	37	TB-CXIN-14E-12	35	6.00
Copper-Constantan with 304 SS sheath	1/16″	TB-CPSS-116G-12	27	TB-CPSS-116U-12	29	TB-CPSS-116E-12	27	1.25
	⅛	TB-CPSS-18G-12	27	TB-CPSS-18U-12	29	TB-CPSS-18E-12	27	2.00
	3/16	TB-CPSS-316G-12	28	TB-CPSS-316U-12	30	TB-CPSS-316E-12	28	2.50
	¼	TB-CPSS-14G-12	31	TB-CPSS-14U-12	33	TB-CPSS-14E-12	31	4.00
Copper-Constantan with Inconel sheath	1/16″	TB-CPIN-116G-12	27	TB-CPIN-116U-12	29	TB-CPIN-116E-12	27	1.50
	⅛	TB-CPIN-18G-12	27	TB-CPIN-18U-12	29	TB-CPIN-18E-12	27	3.00
	3/16	TB-CPIN-316G-12	28	TB-CPIN-316U-12	30	TB-CPIN-316E-12	28	4.00
	¼	TB-CPIN-14G-12	35	TB-CPIN-14U-12	37	TB-CPIN-14E-12	35	6.00

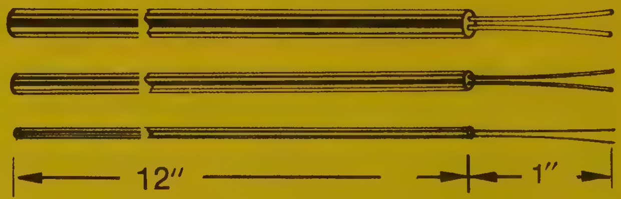
Also Available! Always in Stock! Replacement Probes

Deduct $5.00 from above price list and add suffix RP after catalog designation.

Note:

Other terminations available—

See following pages.



Replacement probes are available with a brass block for installation in a connector—deduct $2 from the TB probe price; add suffix BB to catalog number.

Discount Schedule for Thermocouple Assemblies and Replacement Probes.

Probes:

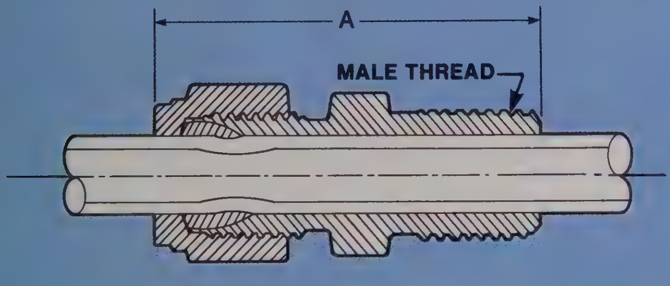
1-9 units	**Net**
10-24 units	**10%**
25-49	**20%**
50-99	**30%**
100 and up	**Consult Sales Department**

Quantity discount applies to like probes. Other sizes, materials and configurations by quotation.

OMEGALOK™ Compression Fittings

Prices start at $3.00

OMEGALOK™ Compression Fittings provide an efficient, convenient means of securing and sealing OMEGA thermocouples, RTDs and other probe-type sensors into tanks, chambers and pipes. The ferrule can be applied at any point along the probe's length. The metal ferrule is deformed when the seal is made which is accomplished by tightening up on the cap nut. Because of this, metal ferrules cannot be reused. Replacement ferrules are available — see below. Pressure ratings are up to 5,000 PSIG depending on material, assembly configuration and service temperature.



Protection Tube O.D.	Male Th'd NPT	"A" In.	Brass		316 Stainless Steel	
			Cat. No.	Pr. Ea.	Cat. No.	Pr. Ea.
1/16	1/16	.97	N/A	—	SSLK-116-116	$12.25
1/16	1/8	1.03	BRLK-116-18	$4.75	SSLK-116-18	12.00
1/8	1/8	1.18	BRLK-18-18	3.00	SSLK-18-18	8.00
1/8	1/4	1.74	BRLK-18-14	3.50	SSLK-18-14	8.50
3/16	1/8	1.22	BRLK-316-18	3.00	SSLK-316-18	8.00
3/16	1/4	1.81	BRLK-316-14	3.50	SSLK-316-14	8.50
1/4	1/8	1.29	BRLK-14-18	3.00	SSLK-14-18	8.00
1/4	1/4	1.48	BRLK-14-14	3.00	SSLK-14-14	7.00
5/16	1/4	1.54	N/A	—	SSLK-516-14	9.00
3/8	1/4	1.59	BRLK-38-14	3.50	SSLK-38-14	9.50
3/8	3/8	1.59	BRLK-38-38	4.00	SSLK-38-38	11.00
3/8	1/2	1.81	BRLK-38-12	5.25	SSLK-38-12	13.50
1/2	1/2	1.94	BRLK-12-12	6.00	SSLK-12-12	15.25

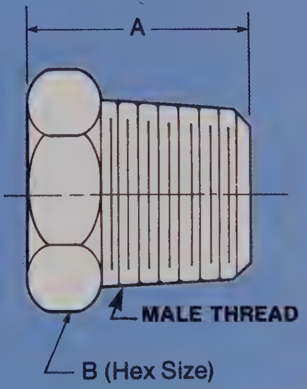
EXTRA & REPLACEMENT FERRULES ARE AVAILABLE.
TO ORDER, STATE PROTECTION TUBE O.D. & MATERIAL.
PR. EA. — BRASS $1.00, STAINLESS $3.00, TEFLON $4.00.

Pipe Thread Reducing Bushings

Prices start at $2.50

OMEGA Reducing Bushings are offered to assist users to adapt OMEGA thermocouple heads, assemblies and other apparatus to a variety of different pipe size openings in tanks, pipelines and chambers.

The fittings are available in both brass and 316 stainless steel. To order, fill in the box which follows the part number with either "BR" for Brass or "SS" for Stainless Steel.



NPT Thread		"B" Hex	"A" In.	Catalog Number	Price Each	
Male	Female				Brass	Stainless Steel
1/2	1/8	7/8	1.09	RB- 12-18-☐	$3.25	$11.50
1/2	1/4	7/8	1.09	RB- 12-14-☐	2.50	8.75
3/4	1/2	1 1/8	1.17	RB- 34-12-☐	4.00	14.00
1	1/2	1 3/8	1.36	RB- 1-12-☐	6.00	24.25
1	3/4	1 3/8	1.36	RB- 1-34-☐	5.00	23.25
1 1/4	3/4	1 3/4	1.48	RB-114-34-CS	N/A	6.25*
1 1/4	1	1 3/4	1.48	RB-114- 1-CS	N/A	8.75*
1 1/2	1	2	1.56	RB-112- 1-CS	N/A	14.75*

FILL IN ☐ WITH "BR" = BRASS,
"SS" = STAINLESS STEEL

* THESE FITTINGS ARE AVAILABLE ONLY IN CARBON STEEL

VERY HIGH

Exotic Thermocouple Probes

Sheaths

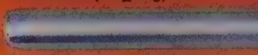
Tantalum • Platinum •
Molybdenum • Inconel

Elements

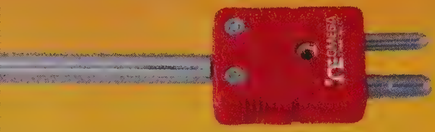
Tungsten/Rhenium •
Platinum/Rhodium

Insulations

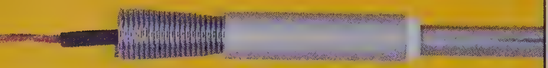
Beryllia (BeO) • Alumina (Al_2O_3) •
Magnesia (MgO)



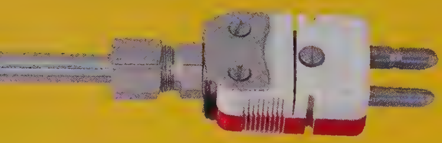
Termination style Q-
type OGP heavy duty, color coded male and female connectors. Add $10 to base price.



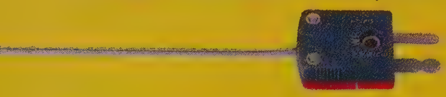
Termination style TJ-
heavy duty transition termination with 72 inch leads. Add $13 to base price.



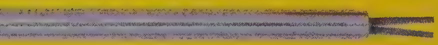
Termination style OX-
type NOX high temperature ceramic color coded male and female connectors. Add $15 to base price.



Termination style S
type SMP color coded subminiature connectors. Add $8 to base price.



Termination style RP-
Replacement probe with 1 inch stripped leads. Add $1.50 to base price.



(Connectors and terminations up to 500°F)

Other Materials and Calibrations Available. Consult Factory for Price and Delivery.

Table 1 High Temperature Sheath Materials

Sheath Material	Maximum Operating Temperature	Workability	Working Environment	Approx. Melting Point	Remarks
††Molybdenum (XMO)	4000°F	Brittle	Inert Vacuum Reducing	4730°F 2610°C	Relatively good hot strength. Sensitive to oxidation above 930°F. Resists many liquid metals, most molten glasses.
†Tantalum (XTA)	4200°F	Malleable	Inert Vacuum	5425°F 3000°C	Resists most acids and weak alkalies. Very sensitive to oxidation above 570°F.
Platinum-Rhodium Alloy (XPA)	3050°F	Malleable	Oxidizing Inert Vacuum	3400°F 1875°C	No attack by SO_2 at 2000°F. Silica is detrimental. Halogens attack at high temperature.
Inconel 600 (XIN)	2100°F	Malleable	Oxidizing Inert Vacuum	2570°F 1410°C	Excellent resistance to oxidation at high temperature. Do not use in presence of sulphur above 1000°F. Hydrogen tends to embrittle.

††Refractory metals are extremely sensitive to any trace of oxygen above approximately 500°F (260°C). Must be used in vacuum or very pure inert gasses such as Helium or Argon.

†Suitable for exposure to certain reducing atmospheres as well as inert gasses and vacuum.

The Maximum Operating Temperature for the cold end of the probe is 425° for termination styles Q, TJ, and S.

Table 2 High Temperature Insulations and Wires

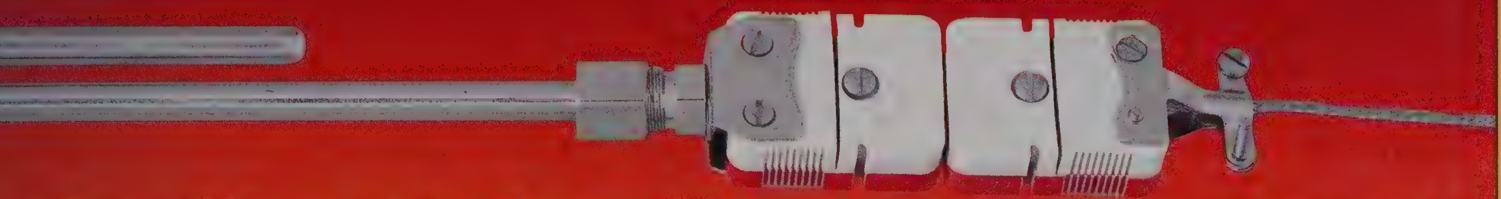
Insulation	Approx. Upper Useful Temperature	Approx. Melting Point	Remarks
Magnesia (MgO)	*3000°F *1650°C	5070°F 2800°C	Hygroscopic, compacts well.
Alumina (Al_2O_3)	*2800°F *1540°C	3660°F 2015°C	Requires considerable volume reduction to compact satisfactorily.
**Berylia (BeO)	*4200°F *2315°C	4620°F 2550°C	Compacts well. High thermal conductivity.
Sensing Wires			
Pt-10% Rh vs. Pt. Pt-13% Rh vs. Pt.	3000°F 1650°C	3200°F 1770°C	Some decalibration at continued high temperature use due to Rhodium volatilization.
W vs. W-26% Re W-5% Re vs. W-26% Re W-3% Re vs. W-25% Re	4200°F 2320°C	5600°F 3100°C	Brittle; avoid flexing.

†At temperatures above 1800°F all insulating materials experience a substantial decrease in resistivity with increasing temperatures.

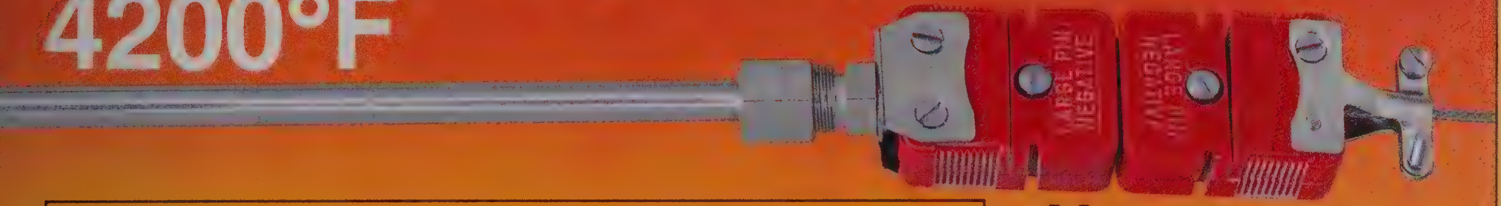
*Values given are for compacted insulation. For uncompacted hard fired insulators, useful temperature range can be 100 to 200°F (38 to 95°C) higher.

**Berylium Oxide and Thorium Oxide are toxic. Do not handle. For any needed repairs or alterations, return to the factory.

TEMPERATURE



for Measuring Temperatures up to 4200°F



Consult Sales Department for Prices

Maximum Service Temp	Recommended Atmosphere O.I.R.V.***	Sheath Calibration Junction Diameter Gage Insulation Termination Length	Recommended Junction Style****	Calibration
4200°F	Vacuum and Inert	XTA -W5R26 -☐- 062 -30 - B -☐-☐	U,G	W5% Re vs. W26% Re
		XTA -W5R26 - -125 -30 - B - -	U,G	
		XTA -W5R26 - -125 -24 - B - -	G	
		XTA -W5R26 - -040 -36 -M- -	E,U,G	
		XTA -W5R26 - -062 -30 -M- -	E,U,G	
		XTA -P13R - -062 -30 -M- -	E,U	Pt vs Pt 13% Rh
		XTA -P13R - -125 -24 -M- -	U	
		XTA -P13R - -062 -30 - B - -	U,G	
		XTA -P13R - -125 -24 - B - -	U,G	
3000°F	O,I,V	XPA -P13R - -062 -30 -M- -	U,G	
		XPA -P13R - -125 -30 -M- -	U,G	
	I,V,R	XMO -W5R26 - -125 -30 - B - - *	G	W5% Re vs W26% Re
		XMO -W5R26 - -250 -30 - B - - *	G	
		XMO -W5R26 - -250 -30 -M- - *	U,G	
	O,I,V	XPA -W5R26 - -062 -30 - A - -	U	
		XPA -W5R26 - -125 -30 - A - -	U	
		XPA -P13R - -125 -24 - A - -	E,U,G	Pt vs Pt 13% Rh
2800°F	I,R,V	XMO -P13R - -125 -30 - A - - *	E,U	
		XMO -P13R - -250 -24 - A - - *	U	
		XMO -W5R26 - -062 -30 - A - - *	U	W5% Re vs W26% Re
		XMO -W5R26 - -125 -30 - A - - *	U	
2100°F	O,I,R,V	XIN -W5R26 - -062 -30 -M- -	E,U	
		XIN -W5R26 - -125 -30 -M- -	U	
		XIN -P13R - -020 -39 -M- -	U	Pt vs Pt 13% Rh
		XIN -P13R - -040 -36 -M- -	U	
		XIN -P13R - -062 -30 -M- -	U	
1600°F	O,I,R,V	XIN -P13R - -125 -30 -M- -	E,U	
		XIN -P13R - -125 -24 -M- -	E,U	
		XIN -P13R - -187 -26 -M- -	E,U	
		XIN -P13R - -250 -24 -M- -	E,U	
		XIN -P13R - -250 -20 -M- -	E,U	

NOTES: All P13R Probes also available with P10R elements.

*Molybdenum sheathed probes cannot be bent.

**All styles and calibrations may not be in stock at all times.

***O—oxidizing, I—inert, V—vacuum, R—reducing atmospheres only

****Recommended atmospheres listed are valid for U and G junction styles only.

Consult Sales Department when using exposed junctions.

Ungrounded junctions on Tungsten/Rhenium thermocouples with compacted insulation have a history of low reliability with premature junction area open circuits. These will be supplied if mandatory, but warranty repairs will not be performed.

Tantalum sheathed probes can be bent, but this must be done at the factory. If the customer chooses to bend a tantalum sheathed probe himself, all warranties are voided.

How to Order

1. Select sheath material (Inconel, Tantalum, Platinum/Rhodium or Molybdenum) from those listed.
2. Select desired calibration from those listed.
3. Determine measuring junction style (E, U or G) and list symbol in first ☐ in model number.
4. Determine desired sheath O.D. from those listed (.040 in., .062 in., .125 in., etc.).
5. Determine desired thermocouple wire gage from those listed (24, 30, 36, 39, etc.).
6. Determine desired insulations from those listed (M designates MgO, B designates BeO, A designates Al_2O_3).
7. Determine desired termination (OX, Q, TJ, S or RP) and insert in second ☐ in model number.
8. Determine desired probe length "L" in inches and fraction of an inch and insert in third ☐ in model number. Fractions of an inch pay for next full inch. Probes under six inches (6") pay for six inch minimum.

Example:

1	2	3	4	5	6	7	8
XTA	**W5R26**	**U**	**062**	**30**	**M**	**TJ**	**7½**

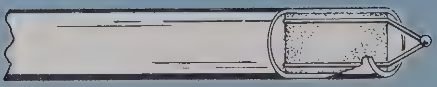
Represents a **(1)** tantalum sheath;
(2) Tungsten 5% Rhenium vs. Tungsten 26% Rhenium element,
(3) ungrounded junction,
(4) 0.062 inch O.D.,
(5) 30 gage wire size,
(6) magnesium oxide insulation,
(7) transition style termination, and
(8) 7½ inch length "L".

Thermocouple Technical Data

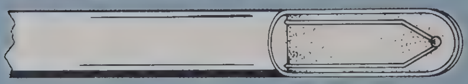
Specifications

Diameters: Standard diameters: 1/16″, 1/8″, 3/16″, and 1/4″ with two wires.
Length: Standard OMEGA thermocouples have 12 inch immersion lengths. Other lengths available.
Sheaths: Type 304 stainless steel and Inconel are standard. Other sheath materials available; write for price and availability.
Insulation: Magnesium Oxide is standard. Minimum insulation resistance wire to wire or wire to sheath is 1.5 megohms at 500 volts dc in all diameters.
Calibration: Iron-Constantan (J), Chromel-Alumel (K), Copper-Constantan (T), and Chromel-Constantan (E) are standard calibrations.
Accuracy: The wires used in OMEGA thermocouples are selected and matched to meet ANSI Limits of Error.
Bending: Easily bent and formed. Bend radius should be not less than twice the diameter of the sheath.
Delivery: Off-the-Shelf, other sheaths available; write for price and delivery.

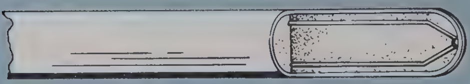
Exposed Junction



Ungrounded Junction



Grounded Junction



Symbol	Recommended Thermocouples Calibration and Use	Positive (+)	Negative (−)	Color Code
T	Copper-Constantan (very low temperature)	Copper (yellow metal)	Constantan (silver metal)	Blue
	Suitable for subzero temperatures. Can be used in oxidizing, reducing, inert or vacuum atmospheres up to 700°F (370°C)			
K	Chromel-Alumel (Oxidizing Atmosphere)	Chromel (Non-magnetic)	Alumel (Magnetic)	Yellow
	Recommended temperature range is −330 to 2300°F (−200 to 1260°C). Should not be used in reducing or sulfurous atmospheres. Can only be used in vacuum for short time until calibration shifts.			
J	Iron-Constantan (reducing atmosphere)	Iron (Magnetic)	Constantan (Non-magnetic)	Black
	Recommended temperature range is 32 to 1400°F (0 to 760°C). Can be used in oxidizing, reducing, inert or vacuum atmospheres.			
E	Chromel-Constantan (high output)	Chromel (Non-magnetic)	Constantan (Non-magnetic)	Purple
	Recommended temperature range is −330 to 1600°F (−200 to 900°C). Can be used in oxidizing or inert atmospheres. Should not be used in reducing or vacuum atmospheres.			

Measuring Junctions

An **exposed junction** is recommended for the measurement of static or flowing non-corrosive gas temperatures where fast response time is required. The junction extends beyond the protective metallic sheath to give accurate fast response. The sheath insulation is sealed where the junction extends to prevent penetration of moisture or gas which could cause errors.

An **ungrounded junction** is recommended for measurements in corrosive environments where it is desirable to have the thermocouple electronically isolated from and shielded by the sheath. The welded wire thermocouple is physically insulated from the thermocouple sheath by MgO powder (soft).

The **grounded junction** is recommended for the measurement of static or flowing corrosive gas and liquid temperatures and for high pressure applications. The junction of a grounded thermocouple is welded to the protective sheath giving faster response than the ungrounded junction type.

Material	Maximum Temperature	Application Atmosphere Oxidizing	Hydrogen	Vacuum	Inert	Applications
304SS	1700°F	Very Good	Good	Very Good	Very Good	Recommended for general chemical applications, food applications, oil refinery use, and steam lines.
Inconel 600	2100°F	Very Good	Good	Very Good	Very Good	Recommended for gas furnaces, lead baths, and bath mixtures containing cyanide. Do not use in salt baths contaminated by sulphur.

Bending: Easily bent and formed. Bend radius should be no less than twice the diameter of the sheath.

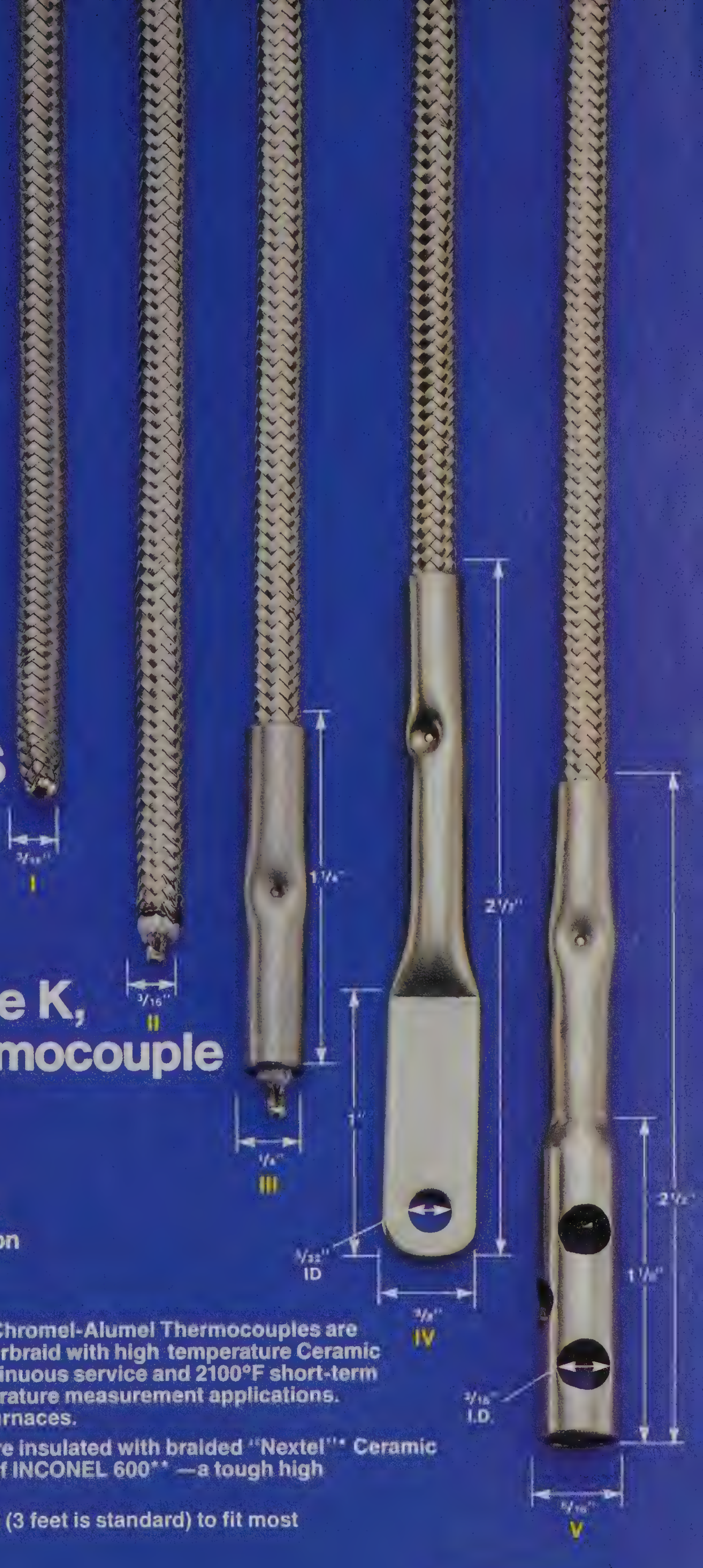
Dual Elements: Thermocouples with a sheath diameter of 0.040″ (1.0mm) thru 1/4″ (6.3mm) are available in dual element.

Accuracy: The wires used in OMEGA thermocouples are selected and matched to meet ANSI Limits of Error. Special limits of error thermocouples can be made from all 1/16″ (1.5mm) O.D. or larger OMEGACLAD™.

Polarity: In the thermocouple industry, standard practice is to color the negative lead red. Other standards that OMEGA uses are: the negative lead of bare wire thermocouple is shorter than the positive lead, and the large pin on a thermocouple connector is always the negative conductor.

Extension Wire: Thermocouple alloy wire must always be used to connect a thermocouple sensor to the instrumentation to assure accurate measurements.

OMEGA's Hi-Temperature Inconel Overbraided, Ceramic Fiber Insulated Thermocouples



Double-Protected Type K, Chromel-Alumel, Thermocouple

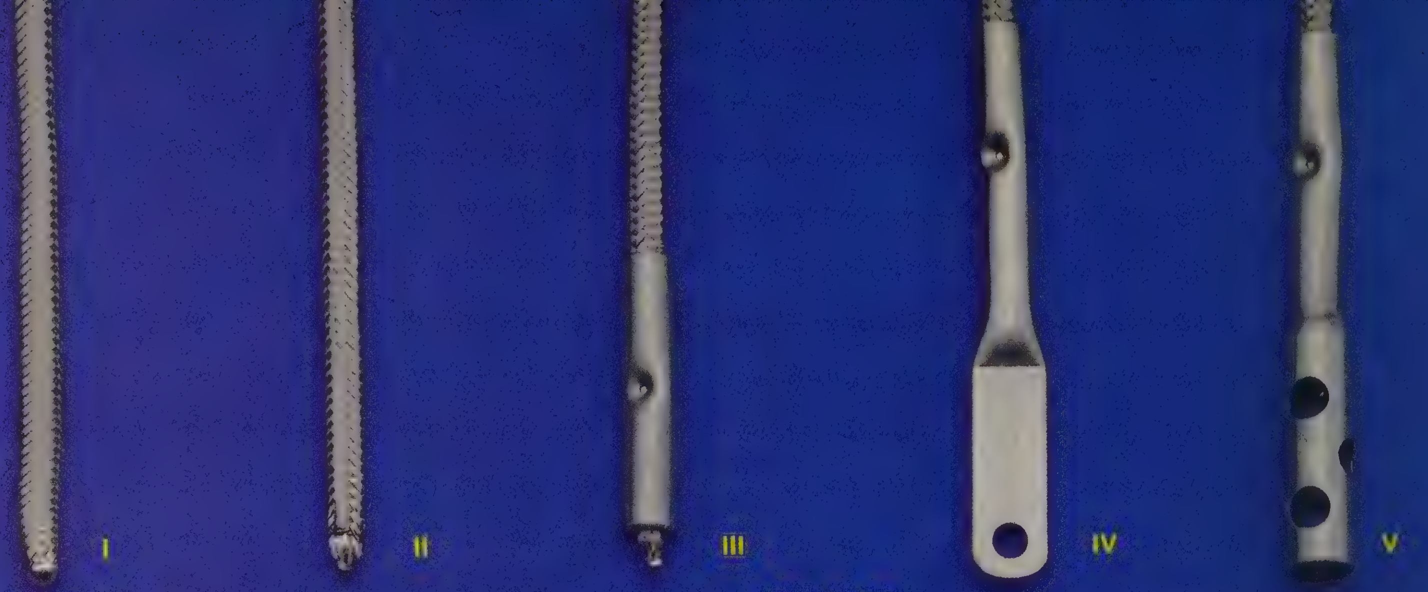
- *Flexible, Abrasion Resistant*
- Withstands Temperatures *Up to 2100°F*
- *Unexcelled* for Oven and Furnace Profiling
- FIVE Convenient Styles for Easy Application
- THREE Convenient Termination Types

Unique OMEGA family of High Temperature type K, Chromel-Alumel Thermocouples are double protected with abrasion-resistant Inconel overbraid with high temperature Ceramic Fiber Insulation. A temperature rating of 1800°F continuous service and 2100°F short-term service make this product ideal for many high temperature measurement applications. This product is unexcelled for profiling Ovens and Furnaces.

The 20-gage solid conductor Thermocouple Wires are insulated with braided "Nextel"* Ceramic Fiber. Over the Ceramic Fiber is a rugged overbraid of INCONEL 600** —a tough high temperature, high nickel content alloy.

Five (5) convenient styles are available in ANY length (3 feet is standard) to fit most High Temperature Measurement applications.

See page A-17 for ordering information



Style I

Style I is a grounded junction thermocouple with the Inconel Overbraid welded to form a smooth rounded tip for all general purpose applications.

Style II

Style II is a general purpose, bead welded, exposed junction thermocouple.

Style III

Style III is an exposed, bead welded, junction thermocouple with a collar to clamp the probe to a surface, or to secure it into a hole on any fabrication.

Style IV

Style IV is available grounded or ungrounded (see Note in pricing table,). It can be bolted to a surface, or the eye can hook the thermocouple to a conveyor flight.

Style V

Style V has an air hood to protect the exposed beaded wire junction. This design can be clamped to a surface, hooked to a conveyor flight, or bolted to a surface by using the through hole at the open end of the hood.

Specifications

Wire Gage: 20 gage solid — standard limits of error.

Calibration: Type K (Chromel-Alumel)

Insulation: "Nextel*" Ceramic Fiber

Overbraiding & Fittings: Inconel 600**

Temperature: 1800°F continuous, 2100°F short-term service

Termination: Ceramic beaded leads with spade lugs made from Type K alloys, or OMEGA OST (425°F) male connector, or OMEGA NOX High-Temperature (1200°F) ceramic Type K male connector

Style	Termination Number	Catalog No.	Price To 3 ft. long	Price Add'l ft. to 50 ft. Total	Price Add'l ft. over 50 ft.
I	1	XCIB-1-1-3 ft	$22	$3.60	$3.00
	2	XCIB-1-2-3 ft	23		
	3	XCIB-1-3-3 ft	25		
II	1	XCIB-2-1-3 ft	22		
	2	XCIB-2-2-3 ft	23		
	3	XCIB-2-3-3 ft	25		
III	1	XCIB-3-1-3 ft	29		
	2	XCIB-3-2-3 ft	30		
	3	XCIB-3-3-3 ft	32		
IV (See Note)	1	XCIB-4-1-3 ft	34		
	2	XCIB-4-2-3 ft	35		
	3	XCIB-4-3-3 ft	37		
V	1	XCIB-5-1-3 ft	39		
	2	XCIB-5-2-3 ft	40		
	3	XCIB-5-3-3 ft	42		

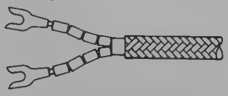
NOTE: For Style IV only: Grounded junction standard; for ungrounded add $10 and write "ungrounded" at end of catalog number.

Length in feet (standard 3 ft)
Termination Type
Style (I, II, III etc.)

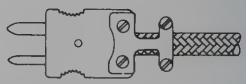
Ordering Example:

XCIB-3-3-18 ft. – Calls out Style III with NOX male connector termination, 18 ft. long.

Termination Number



1. Ceramic Beaded Leads with Compensated Spade Lugs



2. Nylon OST Male Connector (to 425°F)

3. Ceramic NOX Male Connector (to 1200°F)

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*Nextel is a Trade Name of the 3M Corporation.

**Please see section H for Inconel overbraiding.

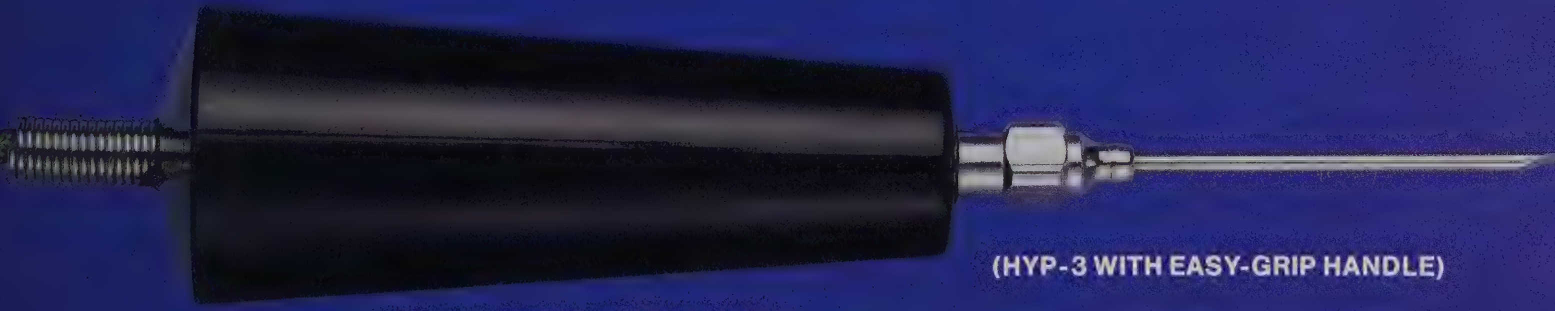
MAGNIFIED VIEW OF HYP-O

Price: **$124**

Model HYP-O Mini Hypodermic Thermocouple Probe

The Model HYP-O autoclavable Mini Hypodermic Probe with a needle diameter of only 0.008" is the least likely to disturb surrounding insertion area. Binocular microscope micro-manufacturing techniques result in an extremely small type T (Copper-Constantan) thermocouple being implanted in a 33 gage (0.008" dia.) 1" long stainless steel hypodermic needle. The HYP-O is the fastest responding hypodermic probe available. It has a continuous temperature rating of 400°F and is supplied with a male SMP miniature connector and 5 feet of 36 gage Teflon lead wire.

CATALOG NO.: HYP-0-33-1-T-G-60-SMP-M



(HYP-3 WITH EASY-GRIP HANDLE)

(Handle not available on HYP-0 and HYP-1)

Easy-Grip Handle Option

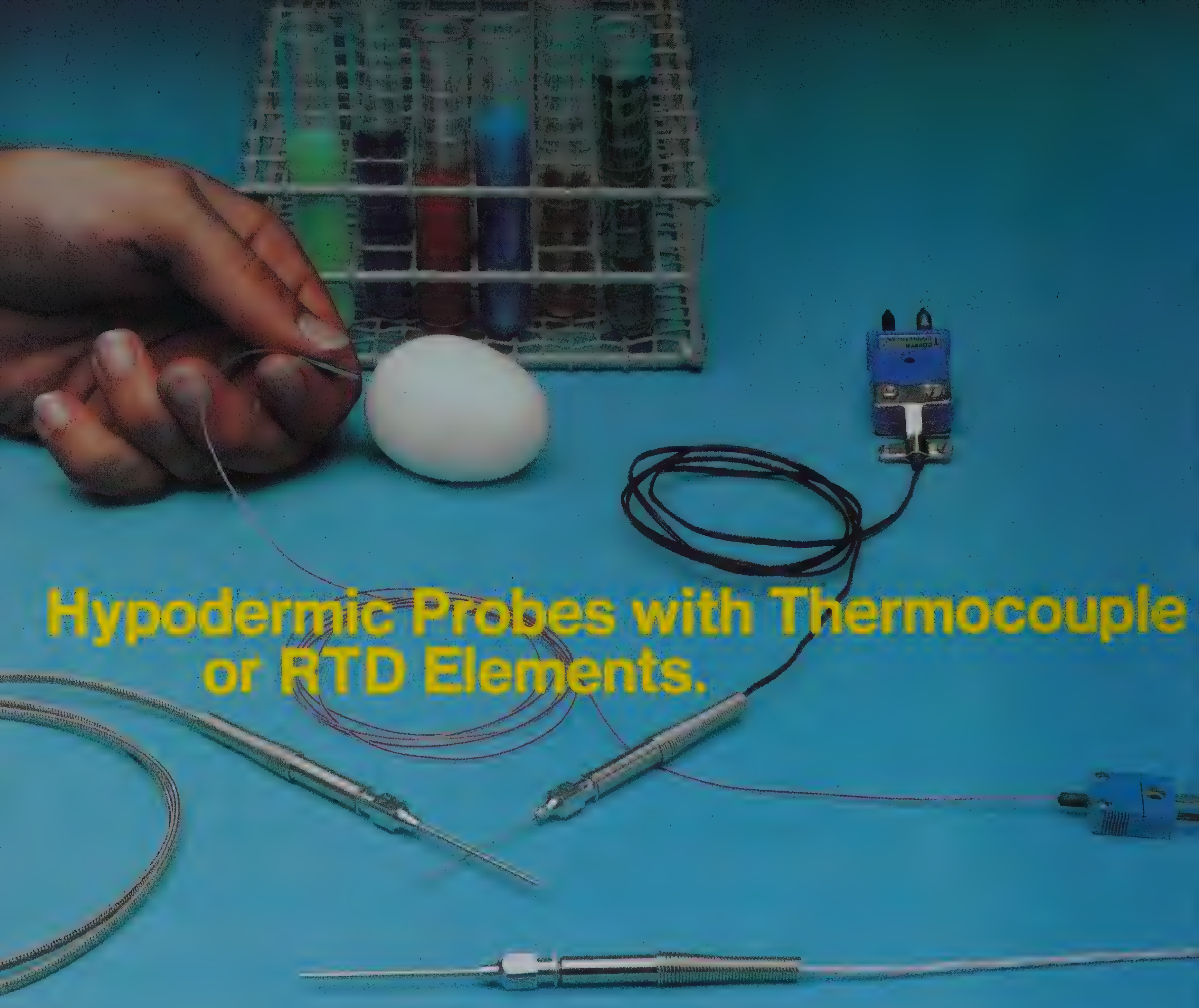
$10

For better control equip your HYP hypodermic probe with an Easy-Grip handle rated for 300°F maximum. This option is available on all OMEGA HYP-2, 3 & 4 probes.

When ordering add EGH (EASY GRIP HANDLE) after the hypodermic probe catalog number.

All probes are designed for industrial, laboratory, manufacturing and chemical research only. **They are not intended for medicinal use, or on humans.** Omega Engineering, Inc. assumes no responsibility if these products are used for medicinal purposes, or on humans, or are misused in any way.

Hypodermic Probes with Thermocouple or RTD Elements.



Off-The-Shelf Delivery

OMEGA ENGINEERING has designed a group of Hypodermic Needle Thermocouple Probes for use in research temperature measurement. Five (5) different probe types are available to cover a multiple of uses.

The HYP-O is the *fastest responding* hypodermic probe available. It features a 33 gage (0.008″ diameter) stainless steel needle 1″ long and is autoclavable. Its extremely small size is least likely to disturb the surrounding insertion area.

The HYP-1 is a research probe designed to give instant readings in plants, liquids and other semi-solids.

This entire assembly is steam autoclavable to a temperature of 325°F; a thirty (30) gage x 1/2″ needle provides very fast response. None of these should be used for human implantation.

The HYP-2 probe has uses in industry, food processing and the natural sciences. This assembly comes complete with a twenty-one (21) gage x 1 1/2″ long hypodermic needle and is also steam autoclavable.

The HYP-3 is OMEGA's Heavy-Duty Industrial Hypodermic Probe. It uses a sixteen (16) gage x 1 1/2″ long needle and is available in several different calibrations.

The HYP-4 probe is offered for the convenience of RTD users. It contains a 100 ohm ($\alpha = .00385$) platinum RTD probe within a sixteen (16) gage x 1 1/2″ hypodermic needle. It is also steam autoclavable.

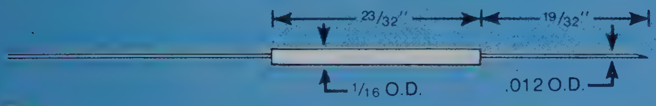
All probes are available in both standard and special sizes. Standard sizes are available "Off-The-Shelf." Please consult the factory for price and delivery on nonstandard sizes.

All probes were designed for industrial, laboratory, manufacturing and chemical research only. **They are not intended for medicinal use, or on humans.** Omega Engineering, Inc. assumes no responsibility if these products are used for medicinal purposes, or on humans, or are misused in any way.

Hypodermic Probes with Thermocouple or RTD Elements.

Thermocouple Probe Model HYP-1

$102



OMEGA Research, autoclavable probe is designed to give instant readings in plants, other semi-solids and liquids. A thirty (30) gage × ½″ needle provides this very fast response. The measurable temperature range is cryogenic to +400°F. This is a type "T" (Copper-Constantan) grounded-junction probe with Teflon insulated extension wire and a subminiature male connector termination. The entire assembly is steam autoclavable to a temperature of 325°F. All probes have five (5) foot leads.

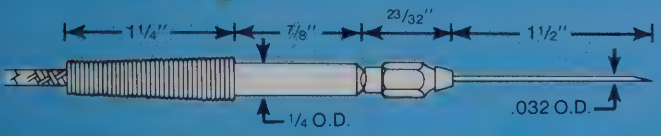
Price—$102

Catalog No. HYP1-30-½-T-G-60-SMP-M

THESE PROBES SHOULD NOT BE USED FOR HUMAN IMPLANTATION.

Thermocouple Probe Model HYP-2

$86



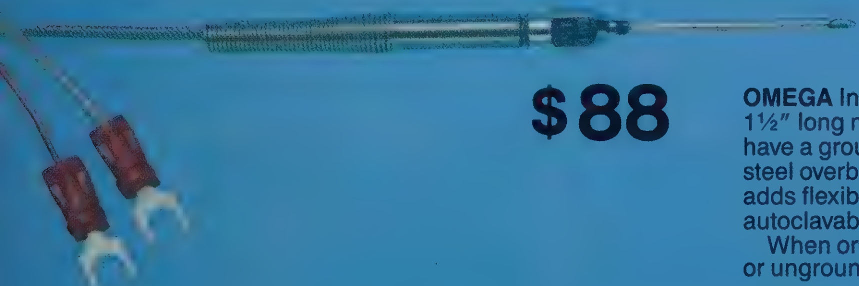
The HYP-2 Probes have Natural Science, Industrial and Food Processing uses. This assembly comes complete with a type "T" (Copper-Constantan) element, forty-eight inch Teflon insulated lead wires, and uses a standard (21 gage) hypodermic needle 1½″ long. These probes are steam autoclavable.

Price—$86

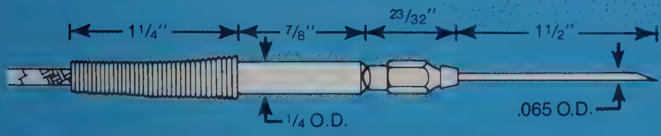
Catalog No. HYP2-21-1-½-T-G-48-OST-M

THESE PROBES SHOULD NOT BE USED FOR HUMAN IMPLANTATION.

Thermocouple Probe Model HYP-3



$88



OMEGA Industrial Hypodermic Probe uses a sixteen (16) gage × 1½″ long needle and may contain J, K, T, E calibrations*; they may have a grounded or ungrounded junction, and come with stainless steel overbraided extension wire. The stainless steel overbraiding adds flexibility and extends the probe life. These probes are *not* autoclavable. They are designed for heavy-duty service.

When ordering, specify calibration and whether grounded or ungrounded junction is desired.

*J = Iron-Constantan
K = Chromel-Alumel
T = Copper-Constantan
E = Chromel-Constantan

Also Available:
R and S (platinum—consult factory for price and delivery.

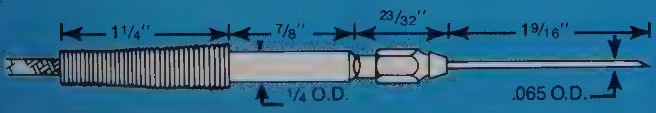
Catalog No. HYP3-16-1-½-☐-☐-48-RP

Select desired calibration from those listed and list symbol in first ☐. Determine measuring junction style (U or G) and list in second ☐.

THESE PROBES SHOULD NOT BE USED FOR HUMAN IMPLANTATION.

RTD Probe Model HYP-4

$88



The RTD Hypodermic Probes are offered for Industrial, Natural Sciences, and Food Processing use. These probes contain a 100 ohm platinum RTD ($\alpha = .00385$) within a sixteen (16) gage × 1½″ hypodermic needle, and come with Teflon insulated lead wire. These steam autoclavable probes are **$88 each.**

Catalog No. HYP4-16-1-½-100-EU-48-RP

THESE PROBES SHOULD NOT BE USED FOR HUMAN IMPLANTATION.

All probes were designed for industrial, laboratory, manufacturing and chemical research only. **They are not intended for medicinal use, or on humans.** Omega Engineering, Inc. assumes no responsibility if these products are used for medicinal purposes, or on humans, or are misused in any way.

Discount Schedule:

1-10 units....Net	25-100 units.10%
11-24 units...5%	101-up 12%

Off-The-Shelf Delivery

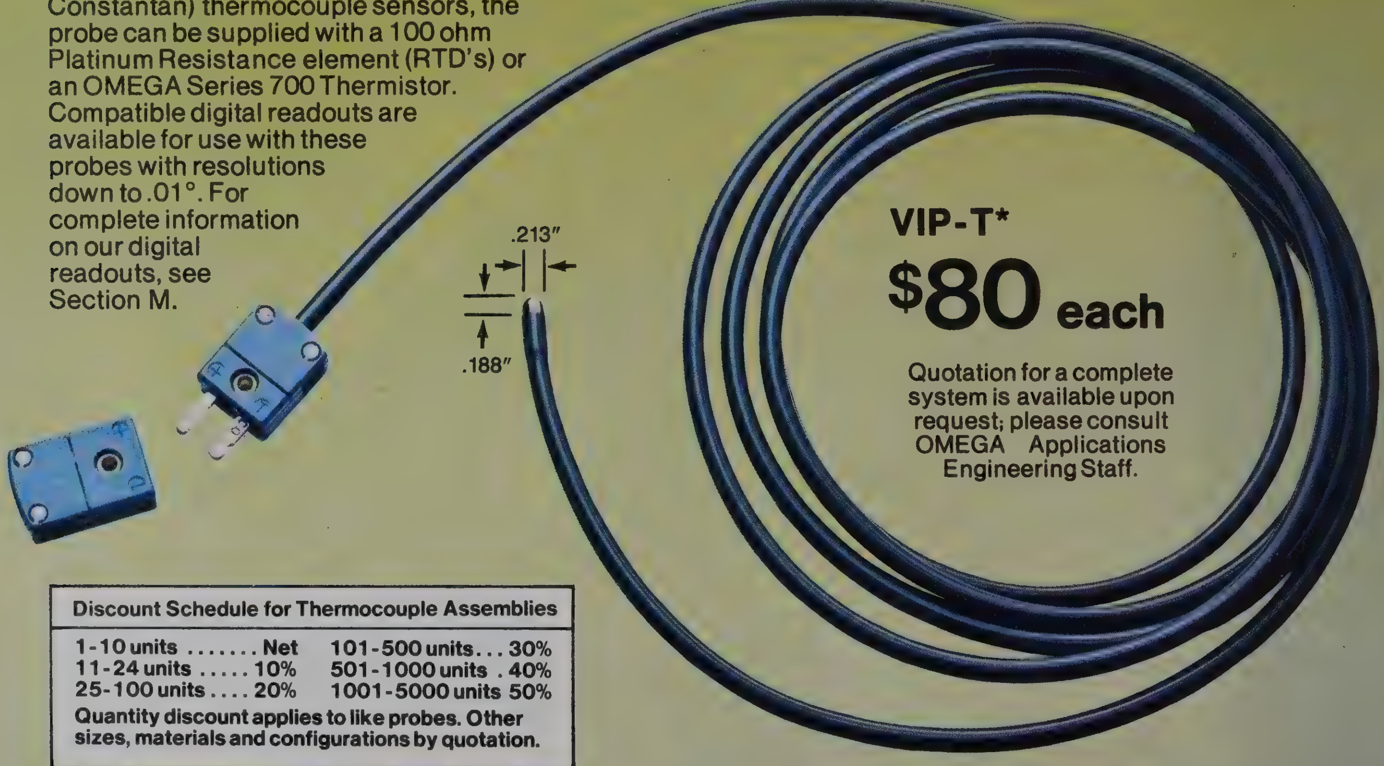
OMEGA VIP Probes
(Veterinary Implantation Probes)

OMEGA VIP's (Veterinary Implantation Probes) are designed for continuous monitoring of animal rectal temperatures. Unique construction make them flexible enough so that they do not cause undue animal discomfort while inserted. They are rigid enough for proper insertion to prevent the animal from discharging the probe during the test period.

Probes are constructed with a specially shaped stainless steel measuring tip with a 7/32″ O.D., 3/16″ long. The transition from the stainless steel tip to the flexible, polyurethane tubing is designed for maximum smoothness. Polyurethane tubing is used to protect the 6 foot stranded thermocouple (Type "T"). The probe terminates in a compensated thermocouple connector pair (SMP-T-MF). Both halves of the connector are included for your convenience. Probes may be cleaned by wiping with an alcohol solution; or other suitable disinfectant solutions. Maximum temperature range is −100°F to +180°F.

In addition to the Type "T" (Copper-Constantan) thermocouple sensors, the probe can be supplied with a 100 ohm Platinum Resistance element (RTD's) or an OMEGA Series 700 Thermistor. Compatible digital readouts are available for use with these probes with resolutions down to .01°. For complete information on our digital readouts, see Section M.

VIP-RTD $115



VIP-T*

$80 each

Quotation for a complete system is available upon request; please consult OMEGA Applications Engineering Staff.

Discount Schedule for Thermocouple Assemblies

1-10 units	Net	101-500 units	30%
11-24 units	10%	501-1000 units	40%
25-100 units	20%	1001-5000 units	50%

Quantity discount applies to like probes. Other sizes, materials and configurations by quotation.

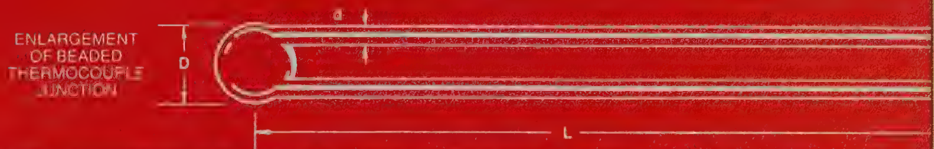
"Pepper the rabbit", courtesy of the Willumsen children

*Copper-Constantan (Type T) thermocouple with six (6) foot leads and miniature ma and female connectors as shown. The VIP-T is supplied grounded as the standard p Also available, ungrounded version. For RTD and thermistor probes, or other lead lengths please consult factory.

Unsheathed Fine Gage Thermocouples

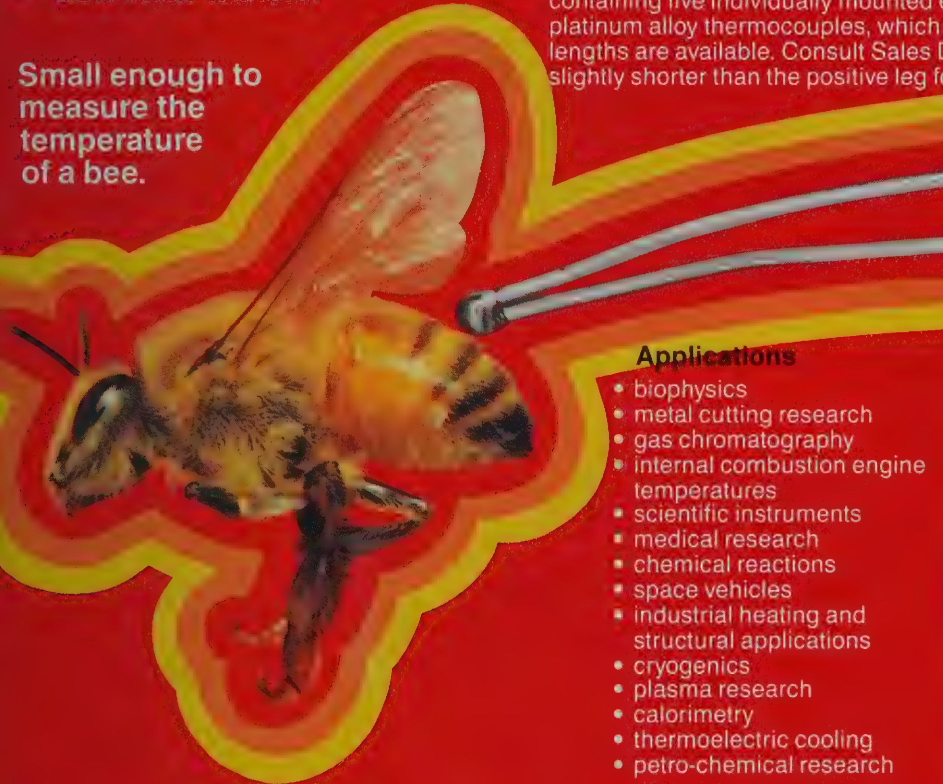
Convenient Packages of 5

- Fast Response
- Diameters down to .0005"
- High Accuracy
- Pin-Point Measurements
- Low Heat Transfer



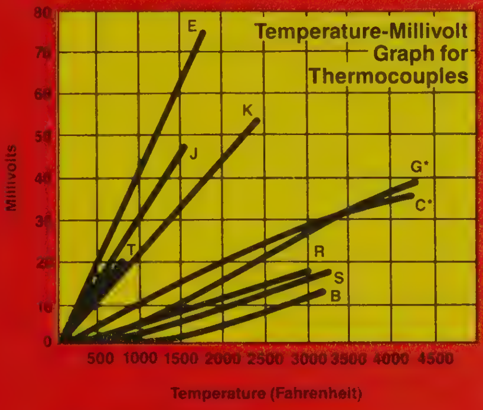
The thermocouples are of the beaded junction type as shown. The bead diameter D is about 3 times the wire diameter d. The thermocouples are supplied in packages containing five individually mounted elements having 12-inch leads, except for platinum alloy thermocouples, which are supplied with 6-inch leads. Other lead lengths are available. Consult Sales Department for details. The negative leg is slightly shorter than the positive leg for easy identification.

Small enough to measure the temperature of a bee.



Applications

- biophysics
- metal cutting research
- gas chromatography
- internal combustion engine temperatures
- scientific instruments
- medical research
- chemical reactions
- space vehicles
- industrial heating and structural applications
- cryogenics
- plasma research
- calorimetry
- thermoelectric cooling
- petro-chemical research



Maximum Service Temperature

Table 1

Thermocouple Type	0.005 inch	0.015 inch	0.020 inch	0.032 inch
J**	600°F	700°F	700°F	900°F
K	1100°F	1600°F	1600°F	1800°F
T	400°F	400°F	400°F	500°F
E	700°F	800°F	800°F	1100°F
R,S	—	—	2642°F	2642°F
B	—	—	3092°F	3092°F

Table 1 lists maximum service temperatures for long term exposures of bare wire thermocouples. For very short exposure times, temperatures of the fine gage thermocouples can be as high as the permissible temperatures for the .032 inch diameter thermocouples.

**Do not expose to oxidizing atmospheres.

Response Time*

Table 2

Wire Size (inches)	Still Air 800°F/100°F	60 ft/sec Air 800°F/100°F	Still H_2O 200°F/100°F
.001	0.05 SEC	0.004 SEC	0.002 SEC
.005	1.0 SEC	0.08 SEC	0.04 SEC
.015	10.0 SEC	0.80 SEC	0.40 SEC
.032	40.0 SEC	3.2 SEC	1.6 SEC

*The time constant is defined as the time required to reach 63.2% of an instantaneous temperature change. The data for Table 2 are obtained by measuring the time required for a Type J fine gage thermocouple to reach 63.2% of its final temperature when its junction is alternately exposed to two different temperature levels. In this case, the time constant was measured for exposures between 800°F and 100°F air and between 200°F and 100°F water.

ANSI Symbol

J	Iron/Constantan	**R**	Pt/Pt 13% Rh
K	Chromel/Alumel	**S**	Pt/Pt 10% Rh
T	Copper/Constantan	**B**	Pt 6% Rh/Pt 30% Rh
E	Chromel/Constantan		

Fine Gage Thermocouples

OMEGA fine gage thermocouples are used whenever fast, accurate temperature measurements are required. The fine wire diameters enable accurate temperature measurements without disturbing the base temperature of the body, in which the installation is made, by keeping heat transfer via the leads to a minimum. Also, the fine junction permits accurate "pin-pointing" of the measured values. They are available in wire sized ranging from 0.0005 to 0.032 inches in diameter. All fine gage thermocouples are made from carefully selected materials. To insure consistent thermoelectric properties, each package contains thermocouples made from matched pairs of wire within the same lot number. When specified, several packages of thermocouples made from the same lot number can be supplied at no extra charge.

Response Time

While thermocouple response is a function of medium of submersion, wire diameter, alloy type and temperature level, it is possible to use Table 2 as a guide for comparing the various wire size thermocouples.

Unsheathed Fine Gage Thermocouples

Important Ordering Notes

Lengths—Prices quoted are for standard twelve (12) inch lengths. Other sizes and lengths are available on special order. Platinum is supplied with six (6) inch leads. A twelve inch length corresponds to a twenty-four inch loop. Longer leads, except platinum alloys—add $4 per foot per package.

Special sizes, alloys or assemblies — Orders for special sizes, alloys or assemblies, should be explicit and accompanied by a sketch or print if possible.

Price List

Materials	Wire Dia. (in.)	Cat. No.	Price Pkg of 5	Materials	Wire Dia. (in.)	Cat. No.	Price Pkg of 5
Iron-Constantan	0.001	IRCO-001	$17	**Chromel-alumel**	†0.0005	CHAL-0005	$ 25
	0.002	IRCO-002	17		0.001	CHAL-001	17
	0.003	IRCO-003	17		0.002	CHAL-002	17
	0.005	IRCO-005	17		0.003	CHAL-003	17
	0.010	IRCO-010	17		0.005	CHAL-005	17
	0.015	IRCO-015	17		0.010	CHAL-010	17
	0.020	IRCO-020	17		0.015	CHAL-015	17
	0.032	IRCO-032	17		0.020	CHAL-020	17
					0.032	CHAL-032	17
Copper-Constantan	0.001	COCO-001	$25	**Pt/Pt-10% Rh***	0.001	P10R-001	$ 31
	0.002	COCO-002	17		0.002	P10R-002	31
	0.003	COCO-003	17		0.003	P10R-003	31
	0.005	COCO-005	17		0.005	P10R-005	36
	0.010	COCO-010	17		0.008	P10R-008	69
	0.015	COCO-015	17		0.010	P10R-010	96
	0.020	COCO-020	17		0.015	P10R-015	190
	0.032	COCO-032	17		0.020	P10R-020	305
					0.032	P10R-032	735
Chromel-Constantan	†0.0005	CHCO-0005	$25	**Pt/Pt-13% Rh***	0.001	P13R-001	$ 31
	0.001	CHCO-001	17		0.002	P13R-002	31
	0.002	CHCO-002	17		0.003	P13R-003	31
	0.003	CHCO-003	17		0.005	P13R-005	36
	0.005	CHCO-005	17		0.008	P13R-008	69
	0.010	CHCO-010	17		0.010	P13R-010	96
	0.015	CHCO-015	17		0.015	P13R-015	190
	0.020	CHCO-020	17		0.020	P13R-020	305
	0.032	CHCO-032	17		0.032	P13R-032	735

*Platinum Alloy Thermocouples are supplied with 6 inch leads.
†0.0005 inch wires supplied with 8 inch leads

Immediate Delivery

Omega Temperature Measurement Products

For Specia
insulated
Thermocouple Prices
and Selections
Turn To Pages
A-26 and A-27

Table 3 — Thermocouple Wire Size and Resistance Table

Resistance in Ohms per Double Foot at 68°F.

AWG No.	Diameter (inches)	ANSI Type K Chromel-P Alumel	ANSI Type J Iron/ Constantan	ANSI Type T Copper/ Constantan	ANSI Type E Chromel/ Constantan	ANSI Type S PT-PT 10% RH	ANSI Type R PT-PT 13% RH
20	.032	.586	.357	.298	.707	.185	.190
24	.0201	1.490	.878	.7526	1.78	.464	.478
26	.0159	2.381	1.405	1.204	2.836	.740	.760
30	.0100	5.984	3.551	3.043	7.169	1.85	1.91
32	.0080	9.524	5.599	4.758	11.31	2.96	3.04
34	.0063	15.17	8.946	7.66	18.09	4.66	4.82
36	.0050	24.08	14.20	12.17	28.76	7.40	7.64
38	.0039	38.20	23.35	19.99	45.41	11.6	11.95
40	.00315	60.88	37.01	31.64	73.57	18.6	19.3
44	.0020	149.6	88.78	76.09	179.2	74.0	76.5
50	.0010	598.4	355.1	304.3	716.9	185.0	191.0
56	.00049	2408	1420	1217	2876	740.0	764.0

*Discount Schedule for Unsheathed Fine Gage Thermocouples in packages of five.

1-10 pkgs	**Net**
11-24 pkgs	**10%**
25-100 pkgs	**20%**
101-500 pkgs	**30%**
501-1000 pkgs	**40%**
1001-5000 pkgs	**50%**

*Does not apply to Platinum Thermocouples

Unsheathed Fine Gage Tungsten–Rhenium Thermocouples

Tungsten-Rhenium thermocouples were developed to meet the requirements for measuring ultra-high temperatures in the 5000°F range.

OMEGA makes available three widely used Tungsten-Rhenium thermocouple calibrations. Tungsten versus Tungsten-26% Rhenium, Tungsten-5% Rhenium versus Tungsten-26% Rhenium and Tungsten-3% Rhenium versus Tungsten-25% Rhenium.

OMEGA Tungsten-Rhenium thermocouples conform to the limits of error listed in the table: "Limits of error for Tungsten Rhenium Thermocouple Wire combinations."

Because of the inherent brittleness of unalloyed Tungsten, the Tungsten versus Tungsten-26% Rhenium thermocouples are more difficult to handle than the Tungsten-5% Rhenium versus Tungsten-26% Rhenium combination.

The average EMF of the W-3% Re/W-25% Re is slightly less than that of W/W-26% Re and slightly more than that of W-5% Re/W-26% Re. The ductility of W-3% Re is about equal to that of W-5% Re, but superior to that of unalloyed Tungsten.

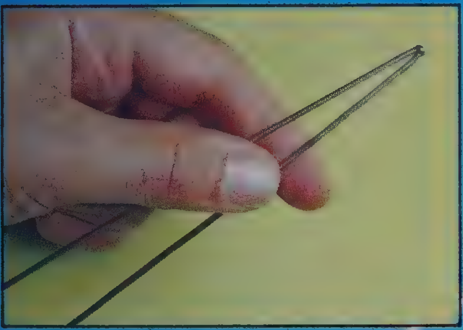
All three thermocouple calibrations can be used to 5000°F in hydrogen or inert gas atmospheres and in a vacuum. They undergo rapid deterioration under oxidizing conditions and should not be used in air or atmospheres containing oxygen.

OMEGA Tungsten-Rhenium thermocouples are supplied in twelve inch lengths (24 inch loop). Longer lead lengths available; consult factory.

Limits of Error for Tungsten-Rhenium Thermocouple Wire Combinations

Wire Diameter (in.)	Temperature Range deg F	Maximum Error or Departure From Values in Tables of Section T*
.003	32-800 800-3200	± 8°F ± 1%
.005	32-800 800-3600	±8°F ± 1%
.010 to .020	32-800 800-4200	± 8°F ± 1%

*Section T of this handbook contains the most current reference tables for all of the most commonly used thermocouple combinations compiled by the National Bureau of Standards.



PRICE LIST Available From Stock.
Other Sizes and Quantities By Quotation.
Prices Subject to Change.

Materials	Wire Dia. (in.)	Catalog No.**	Price per Thermocouple	Price per additional Double Inch
Tungsten-Tungsten 26% Re	.003 .005 .010 .015 .020	T0R-003-12 T0R-005-12 T0R-010-12 T0R-015-12 T0R-020-12	$13 14 23 37 50	$ .50 .75 2.00 3.00 4.00
Tungsten 5% Re-Tungsten 26% Re	.003 .005 .010 .015 .020	T5R-003-12 T5R-005-12 T5R-010-12 T5R-015-12 T5R-020-12	16 18 29 52 66	.80 .95 2.00 4.00 5.00
Tungsten 3% Re-Tungsten 25% Re	.003 .005 .010 .015 .020	T3R-003-12 T3R-005-12 T3R-010-12 T3R-015-12 T3R-020-12	16 18 29 52 66	.80 .95 2.00 4.00 5.00

**Tungsten-Rhenium alloy thermocouples are supplied in standard 12 inch lengths (24 inch loop). Change suffix-12 in catalog designation to indicate additional length required.

Washer Thermocouple Assemblies

Calibration	Washer Size	Screw Size American	Screw Size Metric	Catalog Designation	Price, 12" Leads and Type S Termination	Price Per Add'l Ft.
J Iron Constantan	A	#8	M4	WTJ-8 -□-□	$7	$1.40
	B	#10	M4	WTJ-10 -□-□	7	1.40
	D	1/4"	M6	WTJ-14 -□-□	7	1.40
K Chromel Alumel	A	#8	M4	WTK-8 -□-□	7	1.40
	B	#10	M4	WTK-10 -□-□	7	1.40
	D	1/4"	M6	WTK-14 -□-□	7	1.40
E Chromel Constantan	A	#8	M4	WTE-8 -□-□	7	1.40
	B	#10	M4	WTE-10 -□-□	7	1.40
	D	1/4"	M6	WTE-14 -□-□	7	1.40
T Copper Constantan	A	#8	M4	WTT-8 -□-□	7	1.40
	B	#10	M4	WTT-10 -□-□	7	1.40
	D	1/4"	M6	WTT-14 -□-□	7	1.40

How to Order and Complete Catalog Number

1 Select desired termination style from those listed below and insert in the first (□) provided.

Terminations:
M = Standard Compensated Male Connector, add $5 to price.
S = 3/4" Stripped Ends "Standard".
L = #10 Spade Lugs, add $4 to price.
F = Female Compensated Connector, add $6 to price.

2 Insert the desired lead length in the second (□) provided. Note: 12" leads are standard, with prices given. To order EXTRA lead lengths state desired length in inches and add price for each additional foot indicated.

Washer Dimensions

Washer Style	I.D.	O.D.	Length/ inches
A	11/64	5/16	9/16
B	3/16	3/8	11/16
D	17/64	9/16	15/16

Other Lead Wire Materials Are Available—See Section H.
Other Thermocouple Wire Insulations—Consult Factory for Pricing.
Basic Washer Thermocouple comes with 12 inch solid wire leads and 3/4 inch stripped ends.
Available in J, K, E and T calibrations.
Lead wires covered with high temperature insulation.

Discount Schedule on Thermocouple Assemblies:

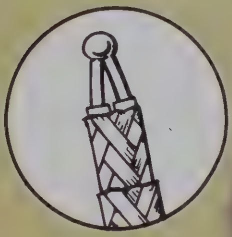
1-10 units . . . . Net	101-500 units 30%
11-24 units 10%	501-1000 units 40%
25-100 units . . . 20%	

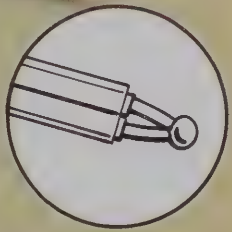
Quantity discount applies to like assemblies. Other sizes, materials and configurations by quotation.

MAXIMUM SERVICE TEMPERATURE 900°F.

Ready Made
Insulated Thermocouples

with Teflon* and Glass Braid Insulation





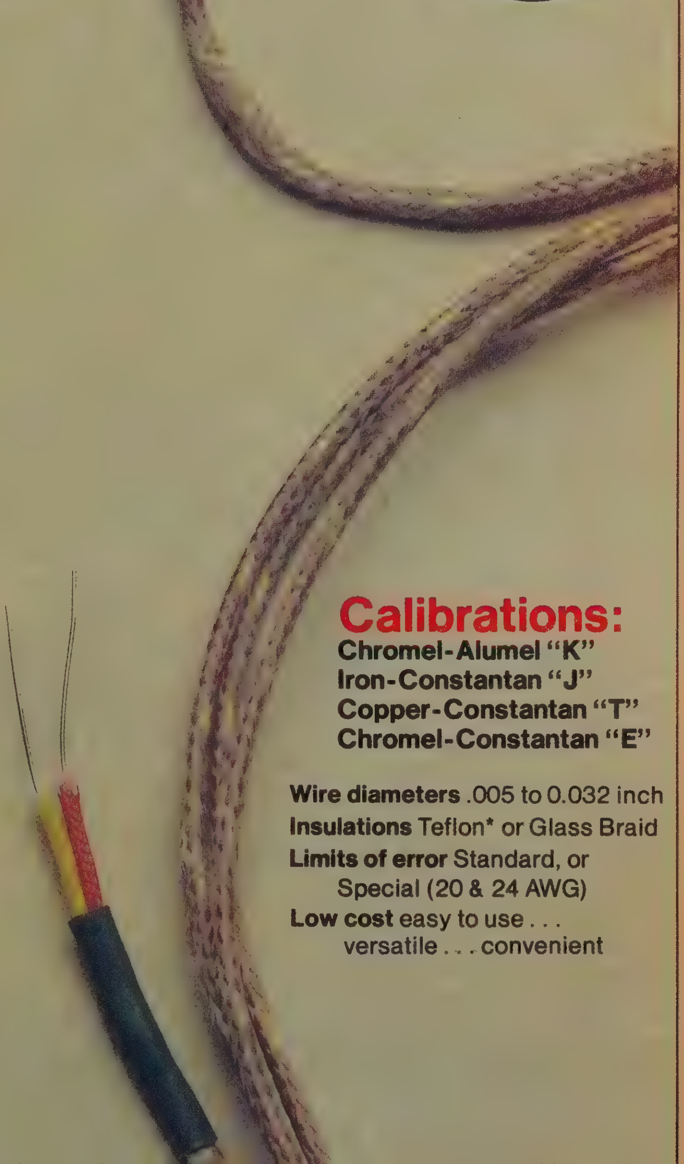
OMEGA insulated, exposed junction thermocouples are used where fast, accurate temperature measurement is required. These pre-made junction thermocouples assure uniformity and precise temperature measurement. They can be used to measure gas, liquid, and surface temperatures.

Thermocouples are supplied in standard thirty-six (36) inch lengths, packages of 5 with either standard or special limits of error. The thermocouples are fabricated from solid wire, having either glass braid or Teflon* insulation. They are available in wire diameters from 0.005 inch to 0.0032 inch. Special limits of error thermocouples are available only in 20 and 24 AWG, and when ordering use "SPL" as the suffix and add 20% to the basic price determined for thermocouples having "Standard Limits of Error."

Ceramic insulated thermocouples are also available. See pages B-11 to B-14 for more details. Specially insulated or constructed thermocouples are also available. Consult Sales Department for price and delivery.

Application Information:

The junction or "bead" diameter of these thermocouples is normally 2½ to 3 times the diameter of each individual thermocouple wire. Estimates of speed of response can be determined from the graphs shown on page T-39 and Table 1, page A-22. Information on wire gage, diameter and wire resistance can be found on page T-38. Data on the glass braid and Teflon insulation can be found on pages H-11 and H-12. The recommended maximum service temperature of Teflon insulation is 500°F. Also, silicone impregnating varnish, which imparts abrasion resistance to the glass braid, is destroyed if used above 400°F. Glass braid is not waterproof. Information on cements can be found in Section J.



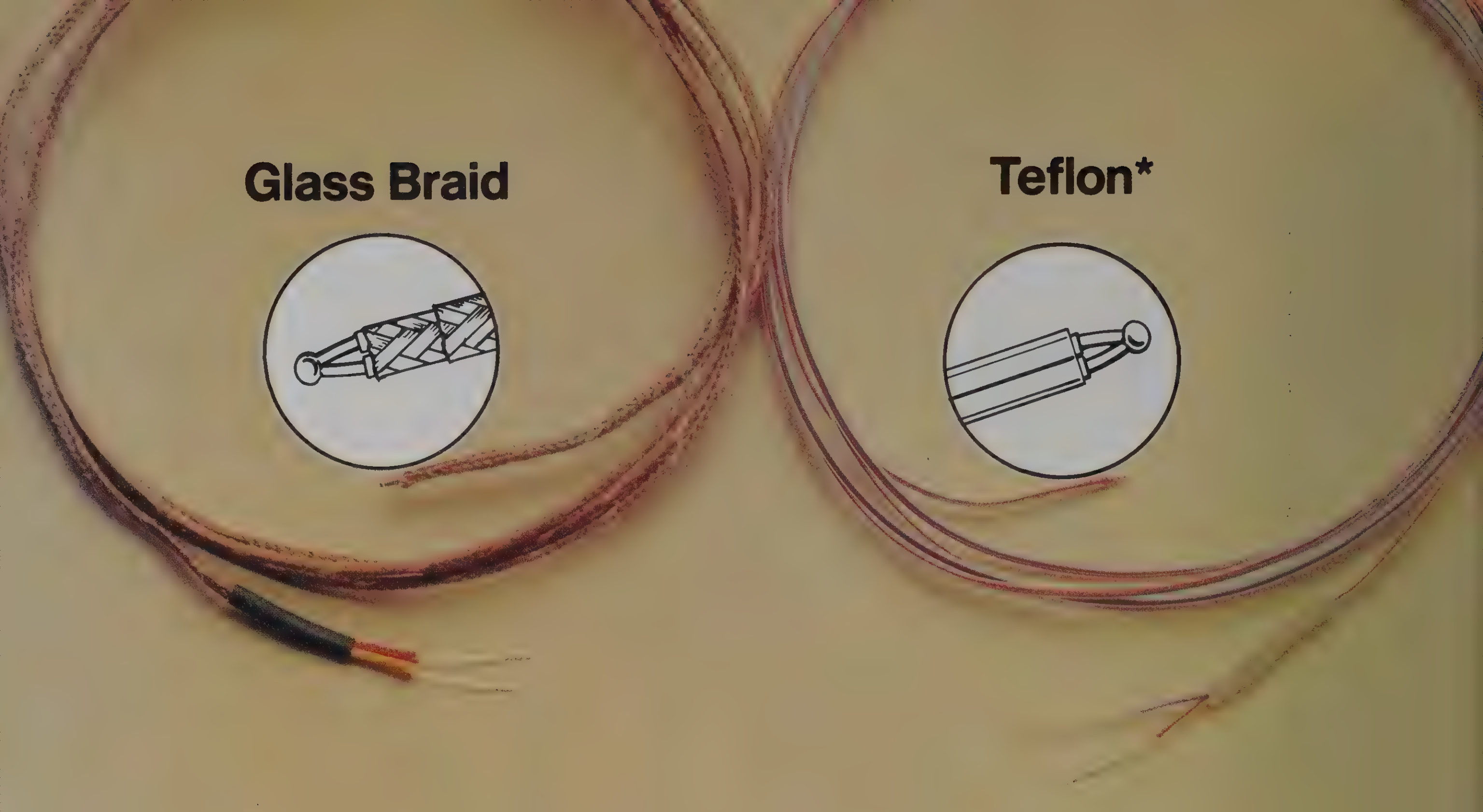
Calibrations:

Chromel-Alumel "K"
Iron-Constantan "J"
Copper-Constantan "T"
Chromel-Constantan "E"

Wire diameters .005 to 0.032 inch
Insulations Teflon* or Glass Braid
Limits of error Standard, or Special (20 & 24 AWG)
Low cost easy to use . . . versatile . . . convenient

---

*Trade name E.I. DuPont.



How to Order:

1. Fill in the first box ☐ with desired thermocouple calibration. Use ANSI symbols — "J" (Iron-Constantan), "K" (Chromel-Alumel), "T" (Copper-Constantan), "E" (Chromel-Constantan).

2. If required length exceeds 36 inches, substitute desired length in inches as last two digits of catalog number. For example, a four foot length becomes 48 inches, etc.

Ordering Example:

5TC-TT-T-24-60 SPL — Calls out 1 pack of 5 thermocouples made from TT-T-24- Special Limits-of-Error Wire, 60 inches long. Price is ($39 + $9) x 1.2 = $57.60

Note:

There will be no set-up charge for lengths greater than standard 36 inches. Determine prices for longer lengths as shown in table. For each additional foot of additional length or fraction thereof, add additional price per pack.

For thermocouples constructed of special limits-of-error wire, add "SPL" as a suffix to standard catalog number in the second box ☐ (only available in 20 or 24 gage). Add 20% to computed standard price. While there is no set-up charge for the order with special limits-of-error, they are not stocked for immediate delivery. For Standard Limits-of-Error, fill in second box with "STD".

Insulation	Wire Dia.	AWG Gage	Catalog Number	Price Pack of 5 T/C 36 inch long	Price Pack of 5 per add'l foot or fraction of length
Glass Braid	.032″	20	5TC-GG-☐-20-36- STD	$39	$4.50
	.020″	24	5TC-GG-☐-24-36- STD	33	4.50
	.010″	30	5TC-GG-☐-30-36- STD	33	4.50
Teflon	.032″	20	5TC-TT-☐-20-36- STD*	50	8.00
	.020″	24	5TC-TT-☐-24-36- STD*	39	4.50
	.010″	30	5TC-TT-☐-30-36- STD	44	8.00
	.005″	36	5TC-TT-☐-36-36- STD	50	8.00

*Not available in "E"

Standard Limits of Error (Special Limits Available on Request, Specify 'SPL')
Length in Inches
Wire Gage
Calibration (J, K, T, E)
Insulation

Discount Schedule for packs of five:

1-10 packs	Net
11-24 packs	10%
25-100 packs	20%
101-500 packs	30%
Over 500 packs	Consult Factory

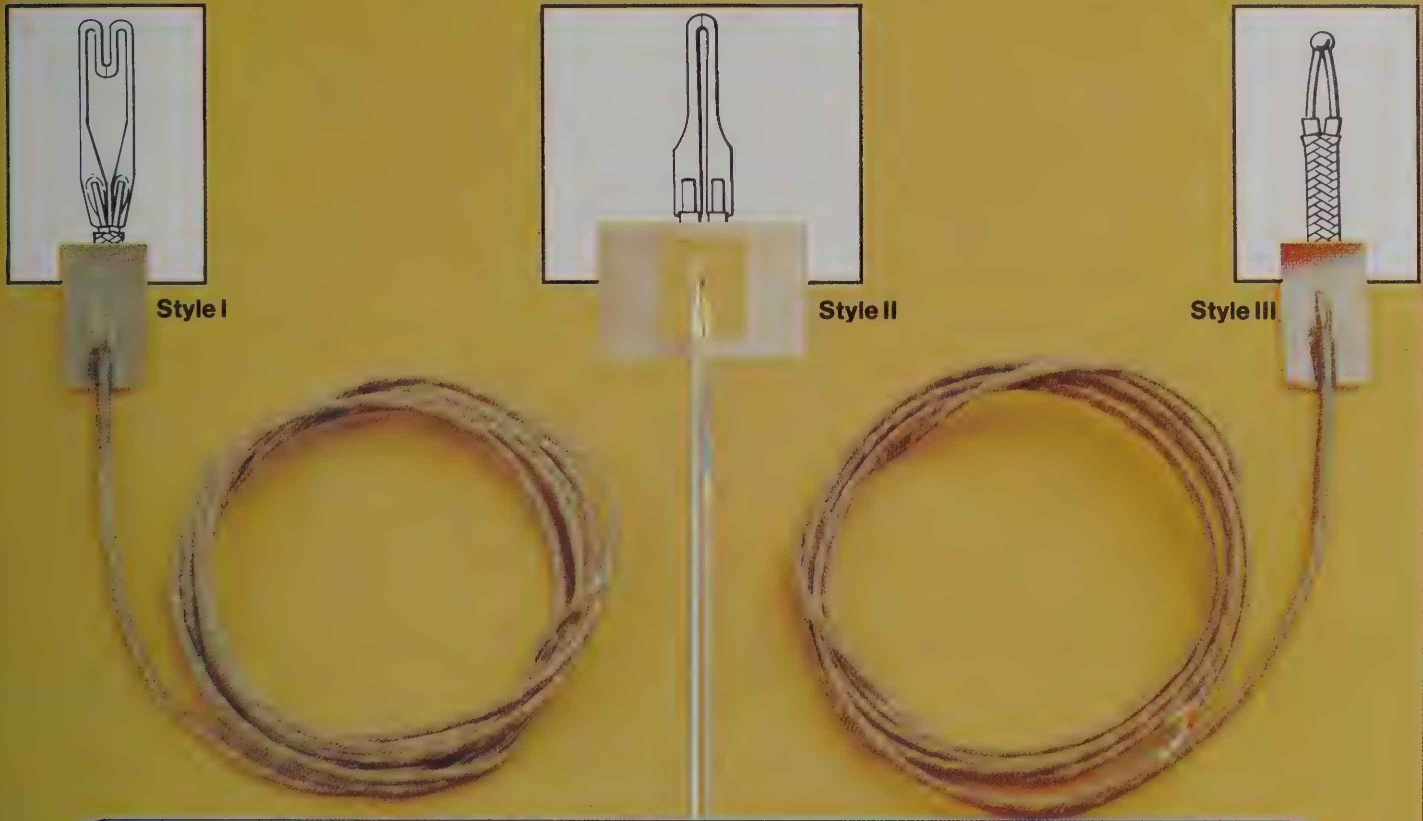
For "Special Limits-of-Error" add 20% to price. There is no set-up charge for lengths greater than 36 inches. Just add to price for additional length.

Superfast Response Time with:
"Cement-On" Thermocouples

- **Response time in milliseconds**
- **Made from 0.0005 inch foil and 0.010 inch diameter thermocouple wire**
- **Very low thermal inertia**
- **Four calibrations "K", "E", "J" and "T"**
- **Three styles ideal for surface measurement**

OMEGA introduces its **Cement-On,** fast response thermocouples for fast surface temperature measurement applications in three convenient styles. Styles I and II are made from 0.0005 inch thermocouple alloy foil by a special process where the butt welded thermocouple junction is 0.0005 inch in thickness. Styles I and II are flat, extremely low inertia construction and are an ideal means of measuring the temperature of both flat and curved metals, plastic and ceramic surfaces where very fast response is desired.

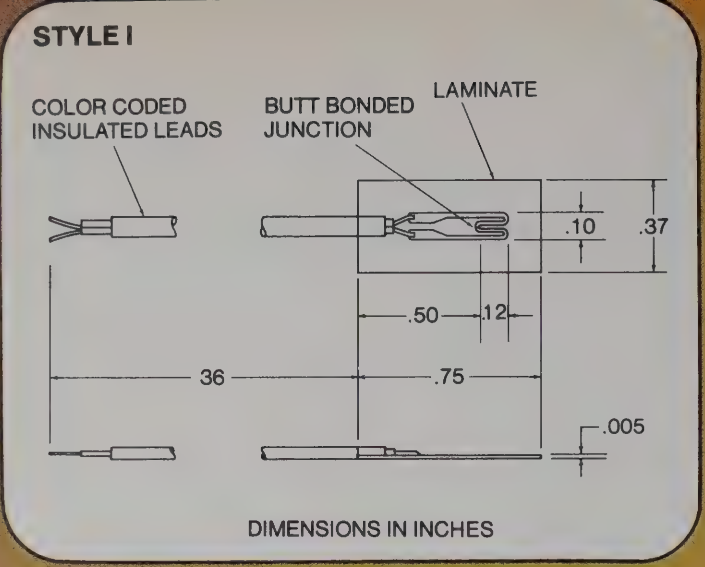
OMEGA's Cement-On Style I and II thermocouples are fabricated from ANSI "Special Limits of Error" grade thermocouple materials in "K", "E" and "T" calibrations and yield accurate temperature indication when used with standard thermocouple instrumentation. Styles I and II have the fastest response. Style III is an economy version constructed from 0.010 inch diameter bead welded standard limit of error thermocouple wire. It should be used where extremely fast response is not essential.



Style	Thermocouple Type	Maximum Temperature °C* Continuous	600 hr.	10 hr.	Catalog Number	Price Each
I	K Chromel-Alumel	260	315	370	CO1-K	$26
	E Chromel-Constantan	260	315	370	CO1-E	26
	T Copper-Constantan	150	205	260	CO1-T	26
II	K Chromel-Alumel	540	540	650	CO2-K	19
	E Chromel-Constantan	425	425	540	CO2-E	19
	T Copper-Constantan	150	150	260	CO2-T	19
III	J Iron-Constantan	260	370	370	CO3-J	13
	K Chromel-Alumel	260	370	370	CO3-K	14
	E Chromel-Constantan	260	370	370	CO3-E	14
	T Copper-Constantan	205	260	370	CO3-T	13

Response time when "grounded" or "cemented" to surface: **Style I—10 to 20 milliseconds, Style II—2 to 5 milliseconds, Style III—300 milliseconds.**
The response time or "time constant" is the time required to reach 63.2% of an instantaneous temperature change.

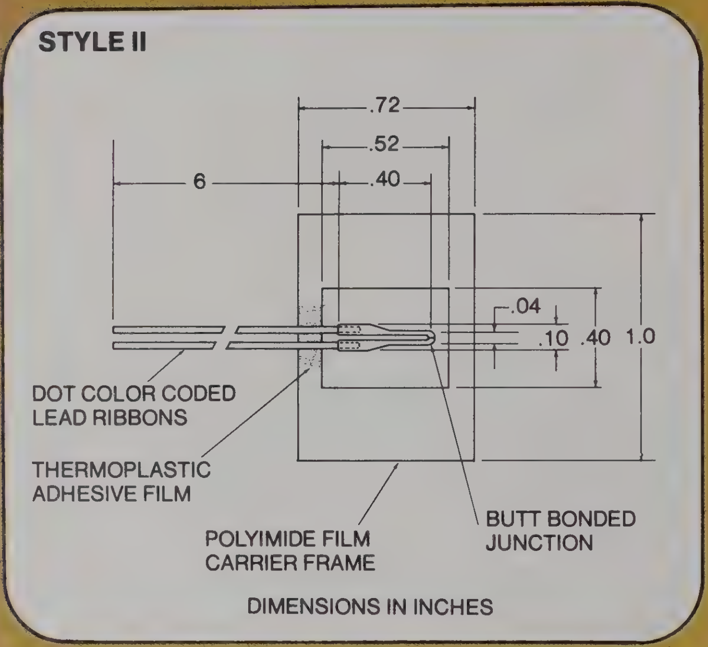
*The temperature range high limits given are greatly influenced by environmental conditions, installation method, accuracy and lifetime requirements and may vary from the general guidelines listed in the table.



STYLE I

Cement-On Style I thermocouples are the easiest to install. The foil sensor is embedded between two paper thin, glass reinforced high temperature polymer laminates which both support and electrically insulate the foil section as well as provide a flat surface for cementing. The polymer/glass laminate, in general, determines the maximum temperature of the construction which is 260°C continuous and up to 370°C for short duration. Each Style I unit includes 3 feet of glass braid insulated 30 gage thermocouple wire which is bonded to the foil and strain relieved by the laminate. An application instruction sheet accompanies each packaged **Cement-On** type thermocouples.

Omegabond "101" and **"200"** epoxies, described on page J-5 and J-6, are recommended for binding Style I **Cement-Ons** to most metals, ceramics, glass, and many plastics.


STYLE II
.72
.52
6
.40
.04
.10
.40
1.0
DOT COLOR CODED LEAD RIBBONS
THERMOPLASTIC ADHESIVE FILM
POLYIMIDE FILM CARRIER FRAME
BUTT BONDED JUNCTION
DIMENSIONS IN INCHES

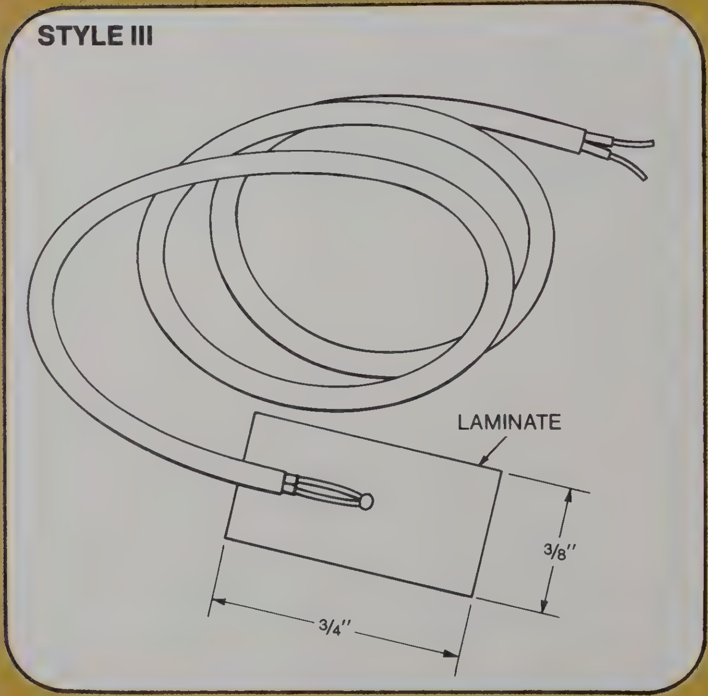
STYLE II

OMEGA Cement-On Style II thermocouples are recommended where extremely fast surface temperature measurement response time is a requirement. Intimate thermal coupling for this style is achieved by directly bonding the foil junction area to the surface to be measured. For ease of handling, the foil leads come fastened to a polyimide film frame which is a tough, flexible, dimensional, stable material rated for 260°C continuous service. During application, the foil thermocouple can be peeled from the frame or released by the application of heat. As an alternate, portions of the frame may be cut away by scissor or knife.

The 6 inch uninsulated foil leads are of .002 inch material and thus are fragile and should be handled with care during installation. NOTE: It is imperative that the leads be electrically insulated from each other as well as being mechanically supported. This can be achieved, for example, by laying and brushing the leads into a layer of insulating cement or epoxy. Before doing this on electrically conductive surfaces, it is best to lay down and let dry, a thin layer of the cement to insure that the leads are truly insulated from the surface. Insulated thermocouple lead wire can be bonded to the foil leads by silver soldering, or resistance welding. Thirty gage, or smaller lead wire is suggested which are listed on Pages H-19 and H-20. An application instruction sheet accompanies each package of thermocouples.

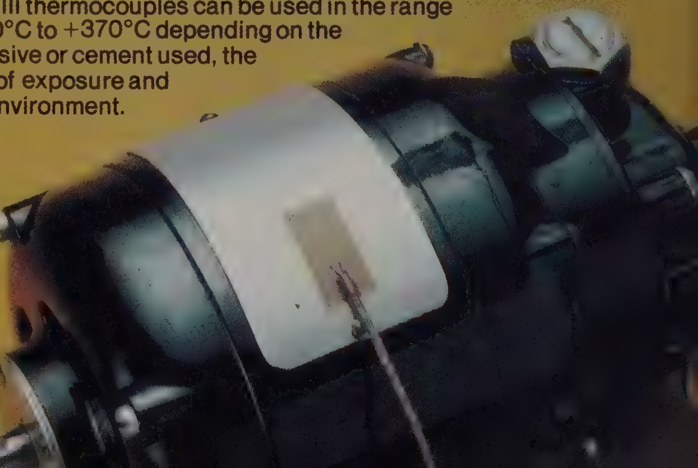
Cementing of the junction and lead may be achieved by using OMEGA CC high temperature cement (Page J-4) for temperatures above 260°C, and **Omegabond "101"** and **"200"** epoxies (Pages J-5 and J-6) for temperatures below this figure.

Please note more care is required to install the Style II than Style I or III. It is suggested that at least one additional unit be ordered as some experimentation may be necessary to learn the technique of application for any of these thermocouples.



STYLE III

OMEGA's Style III thermocouples are constructed of 30 gauge (0.010 inch) diameter "Standard Limits of Error" wire. The thermocouple is bead welded and embedded in a paper-thin laminate intended for surface applications by adhesive bonding. Color-coded, glass braid insulated 36 inch leads are supplied. Style III thermocouples can be used in the range −190°C to +370°C depending on the adhesive or cement used, the time of exposure and the environment.



TEX Probes
For Teflon Extruder

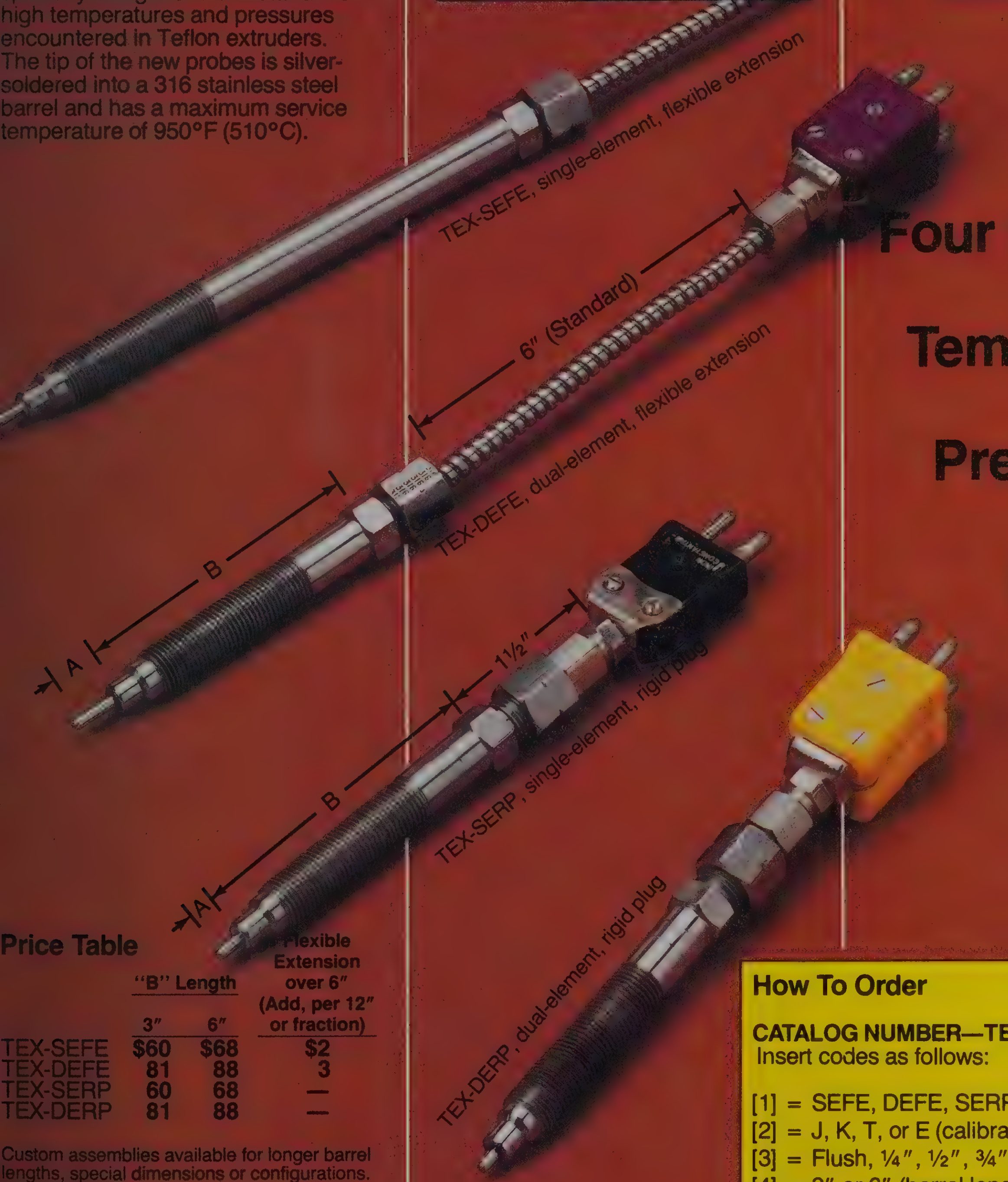
Specifications
- Single or dual elements
- J, K, T, or E calibrations
- OST connectors, rigidly or flexibly attached
- Tip "A" lengths: flush, ¼", ½", ¾", or 1"
- Barrel "B" lengths: 3" or 6"
- Barrel threads: ½-20 NF

These new probes have been specially designed to withstand the high temperatures and pressures encountered in Teflon extruders. The tip of the new probes is silver-soldered into a 316 stainless steel barrel and has a maximum service temperature of 950°F (510°C).

Prices start at

$60

Stainless steel armored cable


TEX-SEFE, single-element, flexible extension
6" (Standard)
TEX-DEFE, dual-element, flexible extension
B
A
1½"
TEX-SERP, single-element, rigid plug
B
A
TEX-DERP, dual-element, rigid plug

Four Styles for the High Temperatures and Pressures of Teflon Extruders

Price Table

	"B" Length		Flexible Extension over 6" (Add, per 12" or fraction)
	3"	6"	
TEX-SEFE	$60	$68	$2
TEX-DEFE	81	88	3
TEX-SERP	60	68	—
TEX-DERP	81	88	—

Custom assemblies available for longer barrel lengths, special dimensions or configurations. Call the Sales Department or send a sketch for quotation.

How To Order

CATALOG NUMBER—TEX—[1]—[2]—[3]—[4]
Insert codes as follows:

[1] = SEFE, DEFE, SERP, or DERP (style)
[2] = J, K, T, or E (calibration type)
[3] = Flush, ¼", ½", ¾" (tip size, "A")
[4] = 3" or 6" (barrel length, "B")

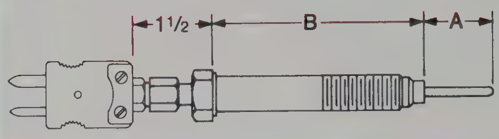
Thermocouples for Plastic Extruders

Service Temperature to 550°F

OMEGA'S Heavy Duty, Plastic Processing Thermocouples mount directly in extruder heads or die adaptors of injection molding machines with the sensor tip projected directly in the plastic melt.

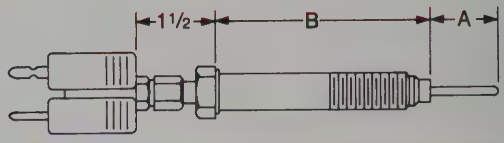
A wide variety of immersion lengths, styles and mounting arrangements are available. All thermocouples are constructed of type 316 stainless steel.

Single Element with Rigid Plug



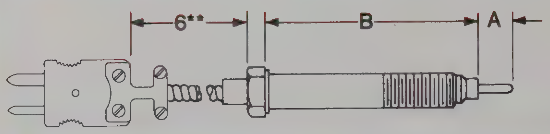
Catalog Number*	"A" Dimension	"B" Dimension	Price
SERP-□-1	Flush	3″	$45
SERP-□-2	1/4″	3″	
SERP-□-3	1/2″	3″	
SERP-□-4	3/4″	3″	
SERP-□-5	1″	3″	
SERP-□-6	Flush	6″	$53
SERP-□-7	1/4″	6″	
SERP-□-8	1/2″	6″	
SERP-□-9	3/4″	6″	
SERP-□-10	1″	6″	

Dual Element with Rigid Plug



Catalog Number*	"A" Dimension	"B" Dimension	Price
DERP-□-1	Flush	3″	$66
DERP-□-2	1/4″	3″	
DERP-□-3	1/2″	3″	
DERP-□-4	3/4″	3″	
DERP-□-5	1″	3″	
DERP-□-6	Flush	6″	$73
DERP-□-7	1/4″	6″	
DERP-□-8	1/2″	6″	
DERP-□-9	3/4″	6″	
DERP-□-10	1″	6″	

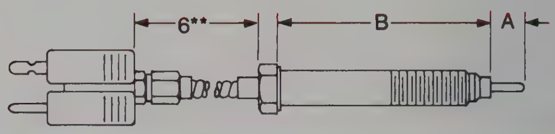
Single Element with Flexible Extension



Catalog Number*	"A" Dimension	"B" Dimension	Price
SEFE-□-1	Flush	3″	$45
SEFE-□-2	1/4″	3″	
SEFE-□-3	1/2″	3″	
SEFE-□-4	3/4″	3″	
SEFE-□-5	1″	3″	
SEFE-□-6	Flush	6″	$53
SEFE-□-7	1/4″	6″	
SEFE-□-8	1/2″	6″	
SEFE-□-9	3/4″	6″	
SEFE-□-10	1″	6″	

**Single element flexible cables are supplied in 6 inch lengths as standard. If greater lengths are desired, add $2 for each additional 12 inches or fraction and specify with order.

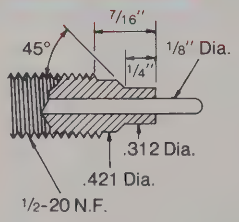
Dual Element with Flexible Extension



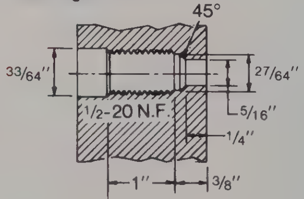
Catalog Number*	"A" Dimension	"B" Dimension	Price
DEFE-□-1	Flush	3″	$66
DEFE-□-2	1/4″	3″	
DEFE-□-3	1/2″	3″	
DEFE-□-4	3/4″	3″	
DEFE-□-5	1″	3″	
DEFE-□-6	Flush	6″	$73
DEFE-□-7	1/4″	6″	
DEFE-□-8	1/2″	6″	
DEFE-□-9	3/4″	6″	
DEFE-□-10	1″	6″	

**Dual element flexible cables are supplied in 6 inch lengths as standard. If greater lengths are desired, add $3 for each additional 12 inches or fraction and specify with order.

Detailed Dimensions



Recommended drilling dimensions for proper mounting in extruder.



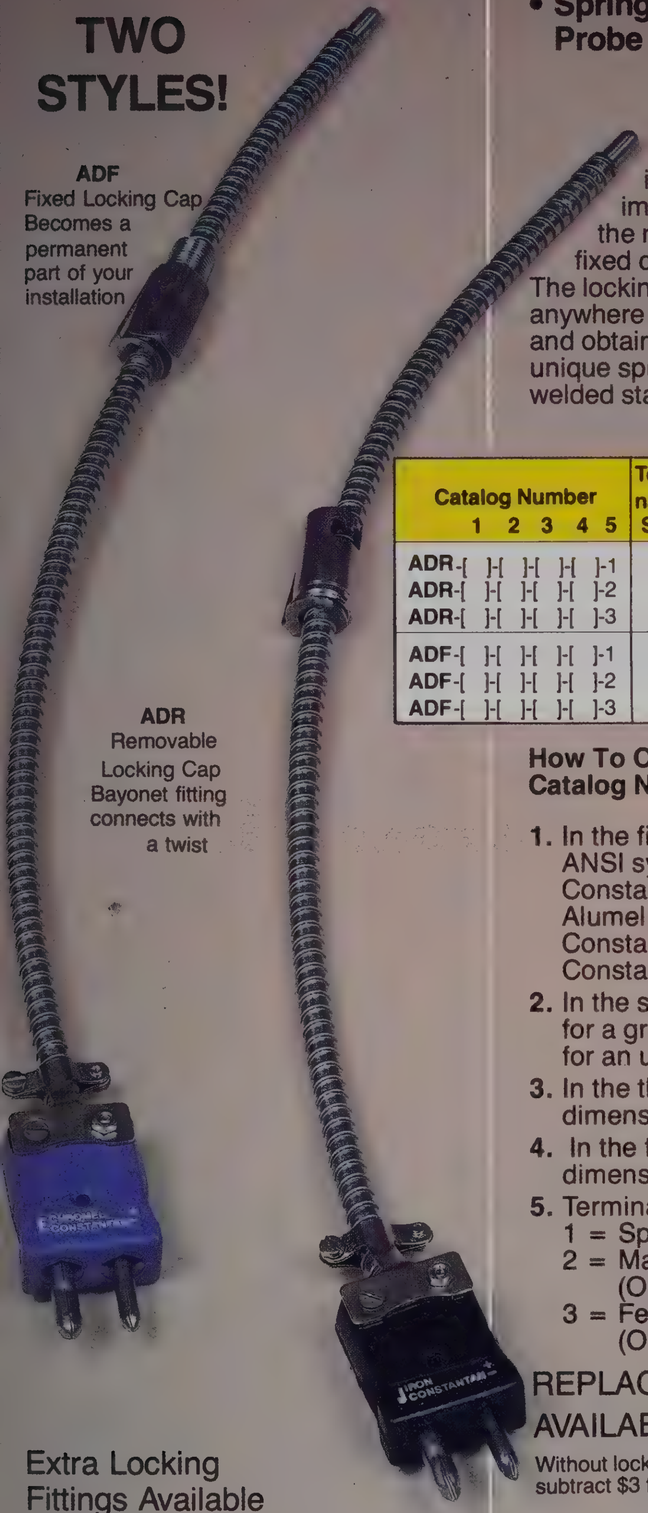
***Important Ordering Notes:** Complete CATALOG NUMBER by inserting ANSI symbol for desired calibration in space (□) provided. ANSI SYMBOL "J" (Iron-Constantan) is usually selected. Other ANSI calibrations are available at NO EXTRA CHARGE. INSERT LETTER SYMBOL J in space provided for Iron-Constantan thermocouples, symbol K for Chromel-Alumel, symbol T for Copper-Constantan, and symbol E for Chromel-Constantan. Single element, *UNGROUNDED* probes available for $6 additional. Dual element, *UNGROUNDED* probes available for $9 additional. (Note: standard units have grounded junctions.

Example: DERP-K-8 signifies a DUAL ELEMENT with RIGID PLUG, plug having an "A" dimension of 1/2″, "B" dimension of 6″, and Chromel-Alumel thermocouple elements.

Discount Schedule:

1-10 units	**Net**	**25-100 units**	**10%**
11-24 units	**5%**	**101-500 units**	**15%**

Adjustable Depth Thermocouples


CHROMEL CONSTANTAN
IRON CONSTANTAN

TWO STYLES!

ADF
Fixed Locking Cap
Becomes a
permanent
part of your
installation

ADR
Removable
Locking Cap
Bayonet fitting
connects with
a twist

Extra Locking
Fittings Available
$5 each

Specify: ADR-LF
or
ADF-LF

- **Locking Fitting Freely Adjustable Over Flexible Armor**
- **Spring Action Catch Holds Probe Firmly in Place**

This unique thermocouple is easy to adjust to ANY immersion depth, eliminating the need to stock a variety of fixed depth immersion probes. The locking cap can be positioned anywhere along the flexible armor and obtains its locking force from a unique spring action catch. The welded stainless steel tipped probe is held against the bottom of the well by the compression of the armor ensuring rapid heat transfer to the thermocouple.

Two styles are available. Style ADF has a unique locking fitting that mounts permanently to your equipment. No adaptors are required. The quick release action of the locking fitting allows fast installation and removal of the probe. Replacement probes are easily stocked because no other fittings are required.

Style ADR has a removable locking fitting and requires a BTA adaptor. This style is ideal for installations where the mounting surface is under a layer of insulation, or where the locking cap must be removable.

Catalog Number 1 2 3 4 5	Termination Style	Base Price	
		Grounded Junction	Ungrounded Junction
ADR-[ ]-[ ]-[ ]-[ ]-1	1	$27	$33
ADR-[ ]-[ ]-[ ]-[ ]-2	2	35	41
ADR-[ ]-[ ]-[ ]-[ ]-3	3	39	45
ADF-[ ]-[ ]-[ ]-[ ]-1	1	29	35
ADF-[ ]-[ ]-[ ]-[ ]-2	2	37	43
ADF-[ ]-[ ]-[ ]-[ ]-3	3	41	47

How To Order and Complete Catalog Number:

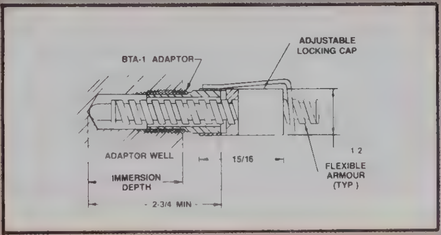
1. In the first space provide the ANSI symbol J for Iron-Constantan; K for Chromel-Alumel; T for Copper-Constantan; and E for Chromel-Constantan.
2. In the second space specify "G" for a grounded junction; or "U" for an ungrounded junction.
3. In the third space specify "A" dimension in inches.(up to 3")
4. In the fourth space specify "B" dimension in inches.(up to 48")
5. Termination styles:
   1 = Spade Lugs
   2 = Male Quick Disconnect (OST Type)
   3 = Female Quick Disconnect (OST Type)

REPLACEMENT PROBES AVAILABLE!

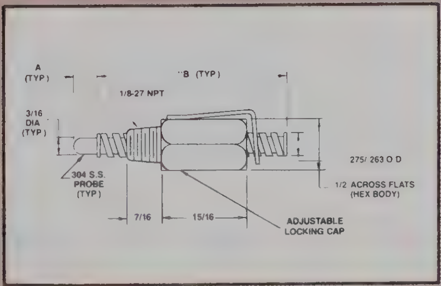
Without locking fittings, add suffix-RP and subtract $3 from price.

Discount Schedule:	
1-10 units	Net
11-24 units	5%
25-100 units	10%
101-500 units	15%

Detailed Dimensions ADR

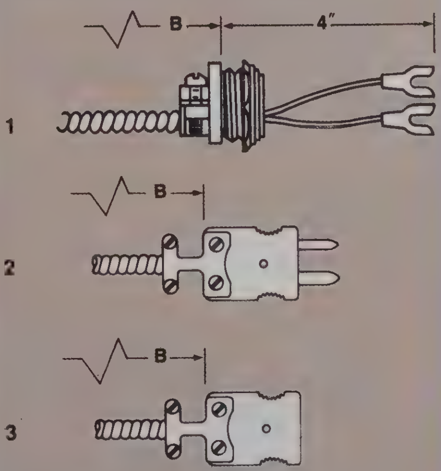

BTA-1 ADAPTOR
ADJUSTABLE LOCKING CAP
ADAPTOR WELL
15/16
1 2
FLEXIBLE ARMOUR (TYP)
IMMERSION DEPTH
2-3/4 MIN

Detailed Dimensions ADF


A (TYP)
"B (TYP)
1/8-27 NPT
3/16 DIA (TYP)
275/ 263 O D
304 S.S. PROBE (TYP)
1/2 ACROSS FLATS (HEX BODY)
7/16
15/16
ADJUSTABLE LOCKING CAP

Design subject to change as engineering improvement permits.

Termination Styles



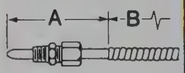
Thermocouples for Plastic Extruders

Service Temperature to 900°F

A wide variety of immersion lengths, styles and mounting arrangements are available. All thermocouples are constructed of type 304 stainless steel.

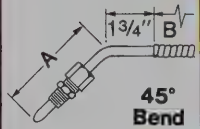
Compression Fitting Type**

(Maximum Service Temperature 900°F)



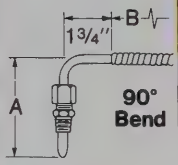
Straight

Catalog Number*	Termination Style	Base Price A to 6″ B to 48″
CF-000-☐-☐-☐-1	1	$21
CF-000-☐-☐-☐-2	2	24
CF-000-☐-☐-☐-3	3	26



45° Bend

Catalog Number*	Termination Style	Base Price A to 6″ B to 48″
CF-045-☐-☐-☐-1	1	$22
CF-045-☐-☐-☐-2	2	25
CF-045-☐-☐-☐-3	3	27



90° Bend

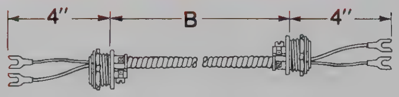
Catalog Number*	Termination Style	Base Price A to 6″ B to 48″
CF-090-☐-☐-☐-1	1	$22
CF-090-☐-☐-☐-2	2	25
CF-090-☐-☐-☐-3	3	27

**1. Compression fitting type and Bayonet type thermocouples have 3/16″ diameter sheaths.
2. Allow 1″ for compression fitting length.
3. Compression fittings are brass with 1/8″ N.P.T. threads

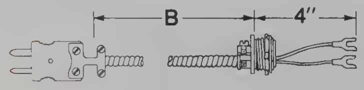
Thermocouple Extension Cable Assemblies

Single Element

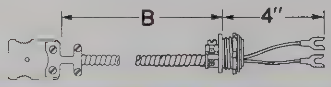
1



2



3



Catalog Number*	Termination Styles		Price** "B" Dimension to 48″
SEEX-☐-☐-1-1	1	1	$15
SEEX-☐-☐-2-1	2	1	20
SEEX-☐-☐-3-1	3	1	22

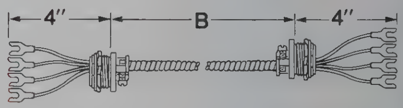
*To complete catalog number, insert desired calibration in first space (☐) provided. Use J for Iron-Constantan, K for Chromel-Alumel, T for Copper-Constantan, and E for Chromel-Constantan.

**Insert desired cable length in inches "B" dimension in second space (☐) provided. Add $2 up to 10 feet and $4 for over 10 feet or fraction of single element extension cable over 48″

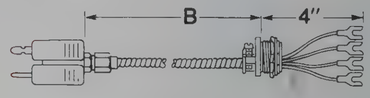
Construction: 3/16″ stainless steel flexible cable.

Dual Element

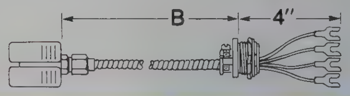
4



5



6



Catalog Number*	Termination Styles		Price** "B" Dimension to 48″
DEEX-☐-☐-4-4	4	1	$20
DEEX-☐-☐-5-4	5	1	25
DEEX-☐-☐-6-4	6	1	27

*To complete catalog number, insert desired calibration in first space (☐) provided. Use J for Iron-Constantan, K for Chromel-Alumel, T for Copper-Constantan, and E for Chromel-Constantan.

**Insert desired cable length "B" dimension in second space (☐) provided. Add $3 up to 10 feet and $5 for over 10 feet.

Construction: 3/16″ stainless steel flexible cable.

*How to Order and Complete Catalog Number:

1. Select desired compression or bayonet type fitting from tables.
2. Determine desired calibration and insert ANSI letter symbol in first space (☐) provided. ANSI letter symbol J (Iron-Constantan) is usually selected. Other standard calibrations offered by OMEGA at **no extra charge** are: K for Chromel-Alumel; T for Copper-Constantan; and E for Chromel-Constantan.
3. Insert desired thermocouple probe dimension "A" in second space (☐) provided in catalog number. A maximum dimension of 6″ can be specified for the base price. The minimum dimension is 2″. Specify "A" dimension to nearest 1/2″. For an inch or fraction over 6 inches, add $1.
4. Insert desired extension cable length dimension "B" in third space (☐) provided in catalog number. Lengths between 4″ and 48″ are available at the base price and 48″ is standard. Add $2 for each additional 12″ or fraction beyond 48″, up to 10 feet; add $4 for each additional 12″ or fraction beyond 10 feet.

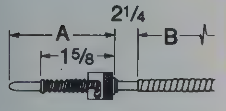
Discount Schedule for Probes Only:

1-10 units......Net	25-100 units...10%
11-24 units.....5%	101-500 units..15%

OMEGA'S rugged Spring Loaded Bayonet Thermocouples are ideally suited for measuring plastic processing machinery temperatures at the crosshead, die and barrel. With OMEGA'S pipe clamp adaptor, they can be used to measure pipe wall and bearing temperatures.

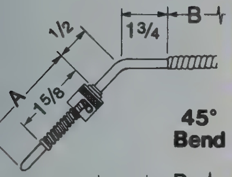
Bayonet Type — Spring Loaded

(Maximum Service Temperature 900°F)



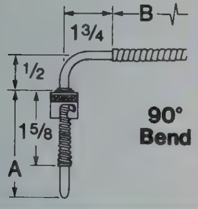
Straight

Catalog Number*	Termination Style	Base Price A to 6" B to 48"
BT-000-□-□-□-1	1	$26
BT-000-□-□-□-2	2	29
BT-000-□-□-□-3	3	31



45° Bend

Catalog Number*	Termination Style	Base Price A to 6" B to 48"
BT-045-□-□-□-1	1	$27
BT-045-□-□-□-2	2	30
BT-045-□-□-□-3	3	32

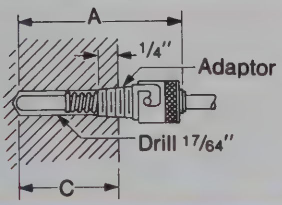


90° Bend

Catalog Number*	Termination Style	Base Price A to 6" B to 48"
BT-090-□-□-□-1	1	$27
BT-090-□-□-□-2	2	30
BT-090-□-□-□-3	3	32

Ungrounded $7 extra.

Drilling and Selection Table for Spring Loaded Bayonet Type Thermocouples

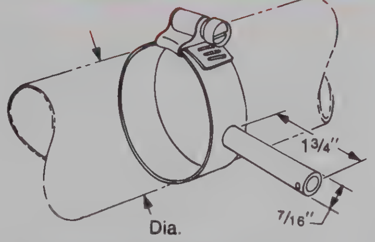


Hole Depth "C" Inches*	Probe Length "A" Inches		
	7/8" Long Adaptor	1 3/8" Long Adaptor	2 1/2" Long Adaptor
1/4 to 1/2	1 5/8	2	3 1/8
1/2 to 1	2	2 1/2	3 5/8
1 to 1 1/2	2 1/2	3	4 1/8
1 1/2 to 2	3	3 1/2	4 5/8
2 to 2 1/2	3 1/2	4	5 1/8
2 1/2 to 3	4	4 1/2	5 5/8
3 to 3 1/2	4 1/2	5	6 1/8
3 1/2 to 4	5	5 1/2	6 5/8
4 to 4 1/2	5 1/2	6	7 1/8
4 1/2 to 5	6	6 1/2	7 5/8

*For deeper holes than those listed, add 1/2 inch to probe dimension "A" for each 1/2 inch of hole depth dimension "C".

Note: Thermocouples supplied less adaptors.

Pipe Clamp Adaptors for Bayonet Type Thermocouples*

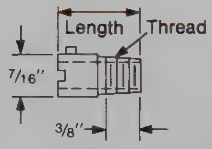


Used for holding pipe. To measure temperature of pipe without drilling. Can be replaced, T/C can be removed.

Catalog Number	For Pipe Diameter (Inches)	
BTC-1	1/2 to 29/32	ALL SIZES $11 each Material is stainless steel
BTC-2	13/16 to 1 3/4	
BTC-3	1 9/16 to 2 1/2	
BTC-4	2 9/16 to 3 1/2	
BTC-5	3 9/16 to 4 1/2	
BTC-6	4 9/16 to 5 1/2	
BTC-7	5 9/16 to 6 1/2	

***Note: Choose "A" thermocouple dimension of 2 1/4 inches for all bayonet type thermocouples used with pipe clamp adaptors.**

Adaptors for Bayonet Type Thermocouples



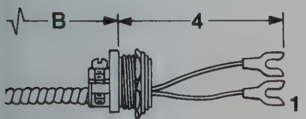
Like a compression fitting, does not seal.

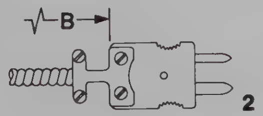
Catalog Number	Length (inches)	Thread Size	Price
BTA-1	7/8	1/8-27 NPT	$6
BTA-2	7/8	3/8-24	6
BTA-3	1 3/8	1/8-27 NPT	7
BTA-4	1 3/8	3/8-24	7
BTA-5	2 1/2	1/8-27 NPT	8
BTA-6	2 1/2	3/8-24	8

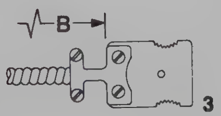
Adaptor material is stainless steel.

Note: Maximum length for Armored Cable is approx. 40 ft.

5. Termination Style:







Dual Elements available

Ordering Example: Catalog Number CF-045-K-4 1/2-44-2 calls for a compression fitting type thermocouple with a 45° bend, Chromel-Alumel (K), with a 4 1/2" probe-length, 44" extension cable, and male plug at the $25 base price.

Discount Schedule:

1-10 units	Net	25-100 units	10%
11-24 units	5%	101-500 units	15%

B

Industrial Thermocouple Assemblies

NB1 and NB2 Protection Head Probes B-3

Platinum-Ceramic Tube Assemblies B-6

Metal Protection Tubes B-7

Ceramic Protection Tubes B-9

Ceramic Insulators, Beads and Tubes B-11

Ceramic Insulated Thermocouple Elements B-14

Protection Heads B-15

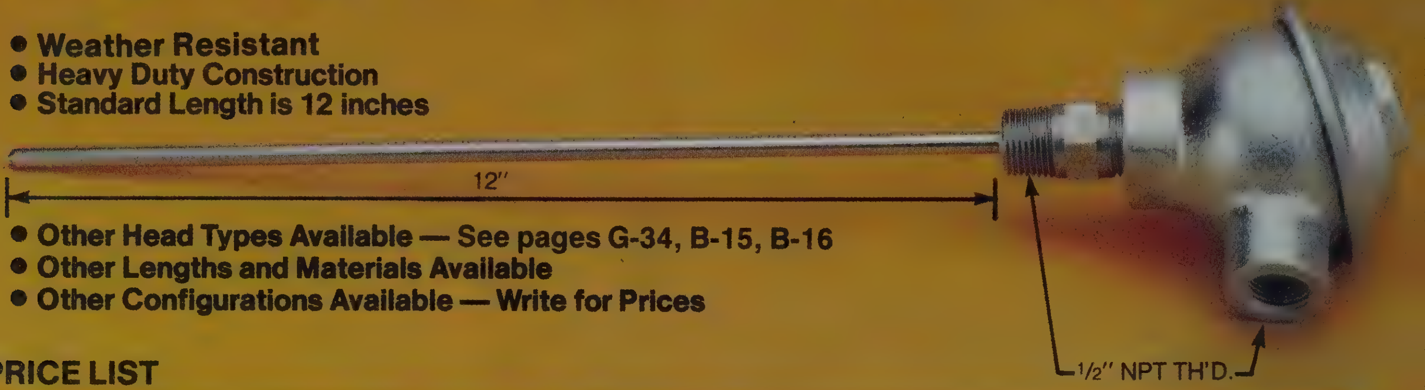
How to Select Thermowells B-18

Head and Well Assemblies B-19

Thermowells B-21

Thermocouple Assemblies with OMEGA®
Heavy Duty, Cast Iron Protection Head

- **Weather Resistant**
- **Heavy Duty Construction**
- **Standard Length is 12 inches**



- **Other Head Types Available — See pages G-34, B-15, B-16**
- **Other Lengths and Materials Available**
- **Other Configurations Available — Write for Prices**

PRICE LIST

	SHEATH* DIAMETER (IN.)	GROUNDED	PRICE	UNGROUNDED	PRICE	EXPOSED	PRICE	PRICE PER ADD'L FT.
IRON CONSTANTAN with INCONEL SHEATH	1/16	NB1 ICIN-116G-12	$42	NB1 ICIN-116U-12	$44	NB1 ICIN-116E-12	$42	$1.25
	1/8	NB1 ICIN-18G-12	$42	NB1 ICIN-18U-12	$44	NB1 ICIN-18E-12	$42	$2.50
	3/16	NB1 ICIN-316G-12	$43	NB1 ICIN-316U-12	$45	NB1 ICIN-316E-12	$43	$3.50
	1/4	NB1 ICIN-14G-12	$47	NB1 ICIN-14U-12	$49	NB1 ICIN-14E-12	$47	$6.00
IRON CONSTANTAN with 304 S.S. SHEATH	1/16	NB1 ICSS-116G-12	$42	NB1 ICSS-116U-12	$44	NB1 ICSS-116E-12	$42	$1.25
	1/8	NB1 ICSS-18G-12	$42	NB1 ICSS-18U-12	$44	NB1 ICSS-18E-12	$42	$1.50
	3/16	NB1 ICSS-316G-12	$43	NB1 ICSS-316U-12	$45	NB1 ICSS-316E-12	$43	$2.50
	1/4	NB1 ICSS-14G-12	$47	NB1 ICSS-14U-12	$49	NB1 ICSS-14E-12	$47	$4.00
CHROMEL ALUMEL with INCONEL SHEATH	1/16	NB1 CAIN-116G-12	$42	NB1 CAIN-116U-12	$44	NB1 CAIN-116E-12	$42	$1.25
	1/8	NB1 CAIN-18G-12	$42	NB1 CAIN-18U-12	$44	NB1 CAIN-18E-12	$42	$2.50
	3/16	NB1 CAIN-316G-12	$43	NB1 CAIN-316U-12	$45	NB1 CAIN-316E-12	$43	$3.50
	1/4	NB1 CAIN-14G-12	$47	NB1 CAIN-14U-12	$49	NB1 CAIN-14E-12	$47	$6.00
CHROMEL ALUMEL with 304 S.S. SHEATH	1/16	NB1 CASS-116G-12	$42	NB1 CASS-116U-12	$44	NB1 CASS-116E-12	$42	$1.25
	1/8	NB1 CASS-18G-12	$42	NB1 CASS-18U-12	$44	NB1 CASS-18E-12	$42	$1.50
	3/16	NB1 CASS-316G-12	$43	NB1 CASS-316U-12	$45	NB1 CASS-316E-12	$43	$2.50
	1/4	NB1 CASS-14G-12	$47	NB1 CASS-14U-12	$49	NB1 CASS-14E-12	$47	$4.00
CHROMEL CONSTANTAN with INCONEL SHEATH	1/16	NB1 CXIN-116G-12	$42	NB1 CXIN-116U-12	$44	NB1 CXIN-116E-12	$42	$1.50
	1/8	NB1 CXIN-18G-12	$42	NB1 CXIN-18U-12	$44	NB1 CXIN-18E-12	$42	$3.00
	3/16	NB1 CXIN-316G-12	$43	NB1 CXIN-316U-12	$45	NB1 CXIN-316E-12	$43	$4.00
	1/4	NB1 CXIN-14G-12	$50	NB1 CXIN-14U-12	$52	NB1 CXIN-14E-12	$50	$6.00
CHROMEL CONSTANTAN with 304 S.S. SHEATH	1/16	NB1 CXSS-116G-12	$42	NB1 CXSS-116U-12	$44	NB1 CXSS-116E-12	$42	$1.25
	1/8	NB1 CXSS-18G-12	$42	NB1 CXSS-18U-12	$44	NB1 CXSS-18E-12	$42	$2.00
	3/16	NB1 CXSS-316G-12	$43	NB1 CXSS-316U-12	$45	NB1 CXSS-316E-12	$43	$2.50
	1/4	NB1 CXSS-14G-12	$47	NB1 CXSS-14U-12	$49	NB1 CXSS-14E-12	$47	$4.00
COPPER CONSTANTAN with INCONEL SHEATH	1/16	NB1 CPIN-116G-12	$42	NB1 CPIN-116U-12	$44	NB1 CPIN-116E-12	$42	$1.50
	1/8	NB1 CPIN-18G-12	$42	NB1 CPIN-18U-12	$44	NB1 CPIN-18E-12	$42	$3.00
	3/16	NB1 CPIN-316G-12	$43	NB1 CPIN-316U-12	$45	NB1 CPIN-316E-12	$43	$4.00
	1/4	NB1 CPIN-14G-12	$50	NB1 CPIN-14U-12	$52	NB1 CPIN-14E-12	$50	$6.00
COPPER CONSTANTAN with 304 S.S. SHEATH	1/16	NB1 CPSS-116G-12	$42	NB1 CPSS-116U-12	$44	NB1 CPSS-116E-12	$42	$1.25
	1/8	NB1 CPSS-18G-12	$42	NB1 CPSS-18U-12	$44	NB1 CPSS-18E-12	$42	$2.00
	3/16	NB1 CPSS-316G-12	$43	NB1 CPSS-316U-12	$45	NB1 CPSS-316E-12	$43	$2.50
	1/4	NB1 CPSS-14G-12	$47	NB1 CPSS-14U-12	$49	NB1 CPSS-14E-12	$47	$4.00

*SEE TABLE ON PAGE H-33 and H-34 FOR PROBE RESISTANCE VS. SHEATH DIAMETER AND LENGTH

See page A-7 for replacement probes

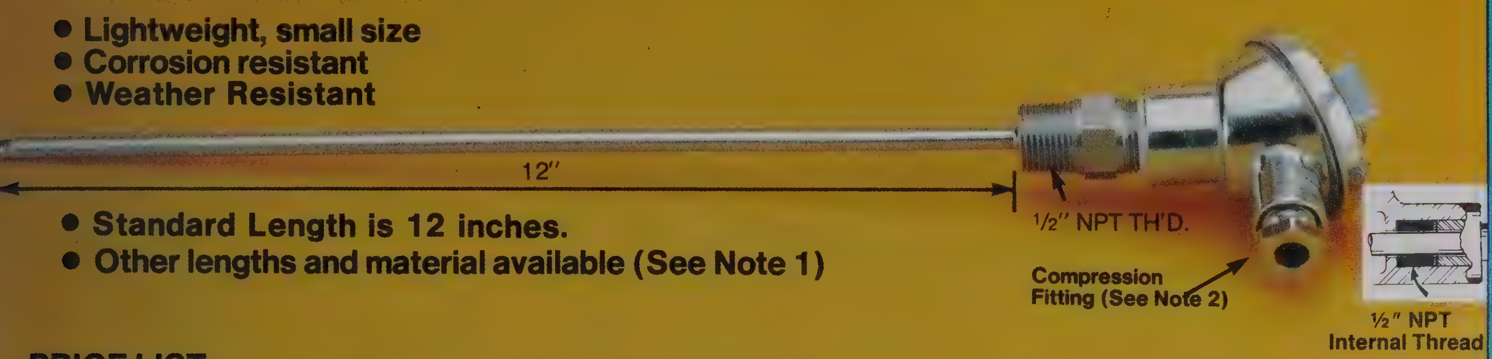
Discount Schedule for Thermocouple Assemblies

1-9 units	Net	50-99 units	30%
10-24 units	10%	100 and up	consult factory
25-49 units	20%		

Quantity discount applies to like probes. Other sizes, materials and configurations by quotation.

Thermocouple Assemblies with OMEGA® Miniature Aluminum, All-Purpose Head

- Lightweight, small size
- Corrosion resistant
- Weather Resistant



- Standard Length is 12 inches.
- Other lengths and material available (See Note 1)

PRICE LIST

	SHEATH* DIAMETER (IN.)	GROUNDED	PRICE	UNGROUNDED	PRICE	EXPOSED	PRICE	PRICE PER ADD'L FT.
IRON CONSTANTAN with INCONEL SHEATH	1/16	NB2 ICIN-116G-12	$42	NB2 ICIN-116U-12	$44	NB2 ICIN-116E-12	$42	$1.25
	1/8	NB2 ICIN-18G-12	$42	NB2 ICIN-18U-12	$44	NB2 ICIN-18E-12	$42	$2.50
	3/16	NB2 ICIN-316G-12	$43	NB2 ICIN-316U-12	$45	NB2 ICIN-316E-12	$43	$3.50
	1/4	NB2 ICIN-14G-12	$47	NB2 ICIN-14U-12	$49	NB2 ICIN-14E-12	$47	$6.00
IRON CONSTANTAN with 304 S.S. SHEATH	1/16	NB2 ICSS-116G-12	$42	NB2 ICSS-116U-12	$44	NB2 ICSS-116E-12	$42	$1.25
	1/8	NB2 ICSS-18G-12	$42	NB2 ICSS-18U-12	$44	NB2 ICSS-18E-12	$42	$1.50
	3/16	NB2 ICSS-316G-12	$43	NB2 ICSS-316U-12	$45	NB2 ICSS-316E-12	$43	$2.50
	1/4	NB2 ICSS-14G-12	$47	NB2 ICSS-14U-12	$49	NB2 ICSS-14E-12	$47	$4.00
CHROMEL ALUMEL with INCONEL SHEATH	1/16	NB2 CAIN-116G-12	$42	NB2 CAIN-116U-12	$44	NB2 CAIN-116E-12	$42	$1.25
	1/8	NB2 CAIN-18G-12	$42	NB2 CAIN-18U-12	$44	NB2 CAIN-18E-12	$42	$2.50
	3/16	NB2 CAIN-316G-12	$43	NB2 CAIN-316U-12	$45	NB2 CAIN-316E-12	$43	$3.50
	1/4	NB2 CAIN-14G-12	$47	NB2 CAIN-14U-12	$49	NB2 CAIN-14E-12	$47	$6.00
CHROMEL ALUMEL with 304 S.S. SHEATH	1/16	NB2 CASS-116G-12	$42	NB2 CASS-116U-12	$44	NB2 CASS-116E-12	$42	$1.25
	1/8	NB2 CASS-18G-12	$42	NB2 CASS-18U-12	$44	NB2 CASS-18E-12	$42	$1.50
	3/16	NB2 CASS-316G-12	$43	NB2 CASS-316U-12	$45	NB2 CASS-316E-12	$43	$2.50
	1/4	NB2 CASS-14G-12	$47	NB2 CASS-14U-12	$49	NB2 CASS-14E-12	$47	$4.00
CHROMEL CONSTANTAN with INCONEL SHEATH	1/16	NB2 CXIN-116G-12	$42	NB2 CXIN-116U-12	$44	NB2 CXIN-116E-12	$42	$1.50
	1/8	NB2 CXIN-18G-12	$42	NB2 CXIN-18U-12	$44	NB2 CXIN-18E-12	$42	$3.00
	3/16	NB2 CXIN-316G-12	$43	NB2 CXIN-316U-12	$45	NB2 CXIN-316E-12	$43	$4.00
	1/4	NB2 CXIN-14G-12	$50	NB2 CXIN-14U-12	$52	NB2 CXIN-14E-12	$50	$6.00
CHROMEL CONSTANTAN with 304 S.S. SHEATH	1/16	NB2 CXSS-116G-12	$42	NB2 CXSS-116U-12	$44	NB2 CXSS-116E-12	$42	$1.25
	1/8	NB2 CXSS-18G-12	$42	NB2 CXSS-18U-12	$44	NB2 CXSS-18E-12	$42	$2.00
	3/16	NB2 CXSS-316G-12	$43	NB2 CXSS-316U-12	$45	NB2 CXSS-316E-12	$43	$2.50
	1/4	NB2 CXSS-14G-12	$47	NB2 CXSS-14U-12	$49	NB2 CXSS-14E-12	$47	$4.00
COPPER CONSTANTAN with INCONEL SHEATH	1/16	NB2 CPIN-116G-12	$42	NB2 CPIN-116U-12	$44	NB2 CPIN-116E-12	$42	$1.50
	1/8	NB2 CPIN-18G-12	$42	NB2 CPIN-18U-12	$44	NB2 CPIN-18E-12	$42	$3.00
	3/16	NB2 CPIN-316G-12	$43	NB2 CPIN-316U-12	$45	NB2 CPIN-316E-12	$43	$4.00
	1/4	NB2 CPIN-14G-12	$50	NB2 CPIN-14U-12	$52	NB2 CPIN-14E-12	$50	$6.00
COPPER CONSTANTAN with 304 S.S. SHEATH	1/16	NB2 CPSS-116G-12	$42	NB2 CPSS-116U-12	$44	NB2 CPSS-116E-12	$42	$1.25
	1/8	NB2 CPSS-18G-12	$42	NB2 CPSS-18U-12	$44	NB2 CPSS-18E-12	$42	$2.00
	3/16	NB2 CPSS-316G-12	$43	NB2 CPSS-316U-12	$45	NB2 CPSS-316E-12	$43	$2.50
	1/4	NB2 CPSS-14G-12	$47	NB2 CPSS-14U-12	$49	NB2 CPSS-14E-12	$47	$4.00

Note 1: For probe length other than 12 inches, change last two digits from 12 to desired length in inches, and add additional price from last column. See pages **H-33** and **H-34** for probe resistance vs. sheath diameter and length.

Note 2: Standard head has compression fitting with rubber ferrule which accepts ⅛″ to ¼″ O.D. wire or tube. Internal thread is ½″ NPT.

Discount Schedule for Thermocouple Assemblies

1-9 units	Net	50-99 units	30%
10-24 units	10%	100 and up	consult factory
25-49 units	20%		

Quantity discount applies to like probes. Other sizes, materials and configurations by quotation.

Industrial Process Probes

Spring Loaded

Replacement Probe

- **For Use in Wells**
- **Faster Response**
- **J, K, T, and E**

Spring loaded thermocouples are designed to provide a fast response when used in a thermowell. Approximately ½″ (12 mm) of travel is standard. Thermocouple junction cannot be damaged when installed into a thermowell. This probe is also ideal for use as a bearing sensor.

To Order: Add Suffix-RP-SPRING LOADED to part numbers of NB1 and NB2 probes shown on pages B-3 or B-4.

Example: NB1-ICSS-316G-12-RP SPRING LOADED

Price: NB1-RP price plus $10

½″ NPT Mounting Thread

- **12″ (304 mm) Length Stock**
- **Inconel or 304 Stainless Steel Sheath**
- **J, K, T and E Calibrations in Stock**
- **1/16″ (1.5 mm), 1/8″ (3.1 mm), 3/16″ (4.7 mm), and 1/4″ (6.3 mm) Diameters In Stock.**

½″ NPT mounting thread probes are supplied with a hex nipple for attachment to tank walls, pipe fittings, or conduit. The fitting is silver soldered to the probe sheath for a positive pressure seal. Supplied with 1½″ (38 mm) of bare leads with epoxy seal.

Dual Elements Available
Keep several spares on hand

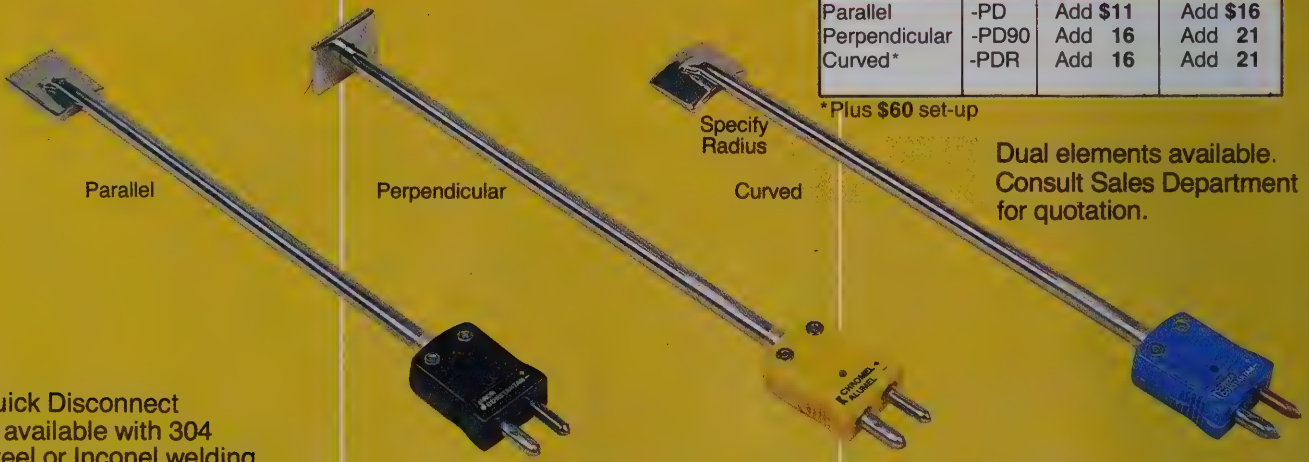
Replacement Probe

To Order: Add suffix RP to part numbers of NB1 and NB2 probes shown on pages B-3 and B-4.

Example: NB1-CAIN-14G-12-RP

Price: NB1 price less $14

Weld Pad Probes



Weld Pad Probe	Suffix	Price	
		304SS	Inconel
Parallel	-PD	Add $11	Add $16
Perpendicular	-PD90	Add 16	Add 21
Curved*	-PDR	Add 16	Add 21

*Plus $60 set-up

Dual elements available. Consult Sales Department for quotation.

OMEGA Quick Disconnect probes are available with 304 stainless steel or Inconel welding pads for permanent installation. These rugged assemblies are available in three styles, Parallel, Perpendicular, and Curved, to meet most industrial applications.

Dimensions: 1″ × ¾″ × ⅛″

To Order: Select a Quick Disconnect style to meet your needs from page A-9 and add the weld pad suffix from the table.

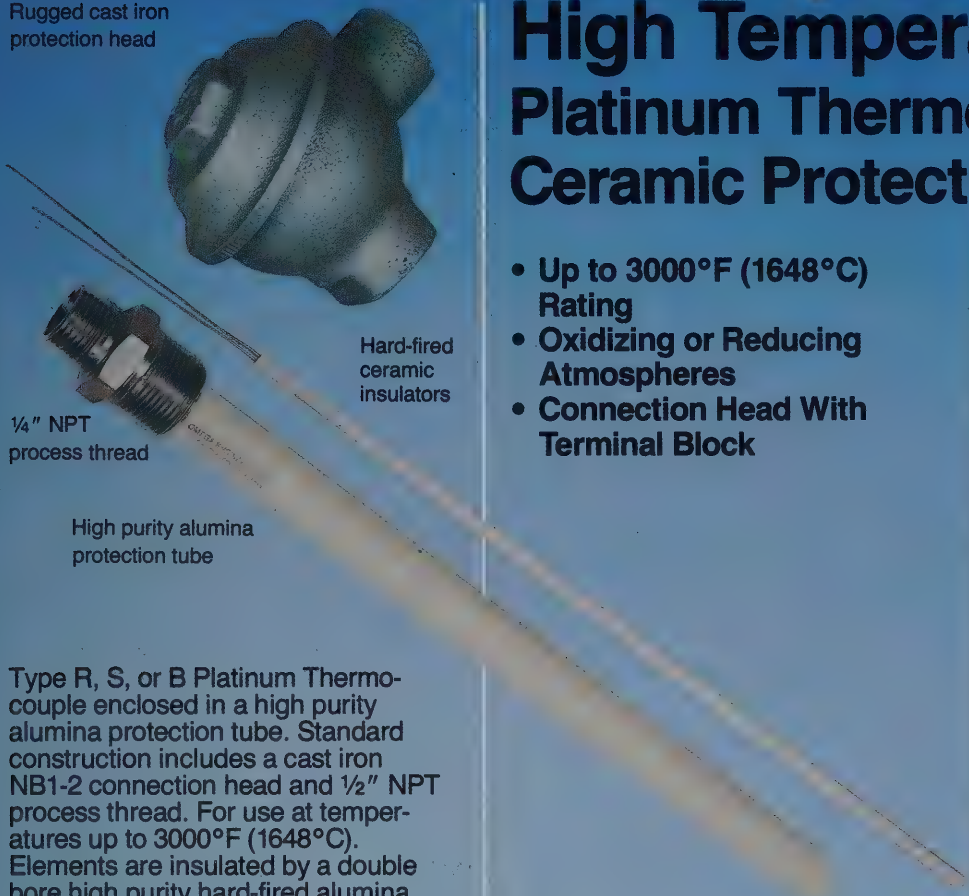
Example: ICSS-14G-12-PD
Iron-Constantan quick disconnect thermocouple ¼″ dia., 12″ long, stainless steel sheath with a parallel weld pad.

Thermocouple Assemblies

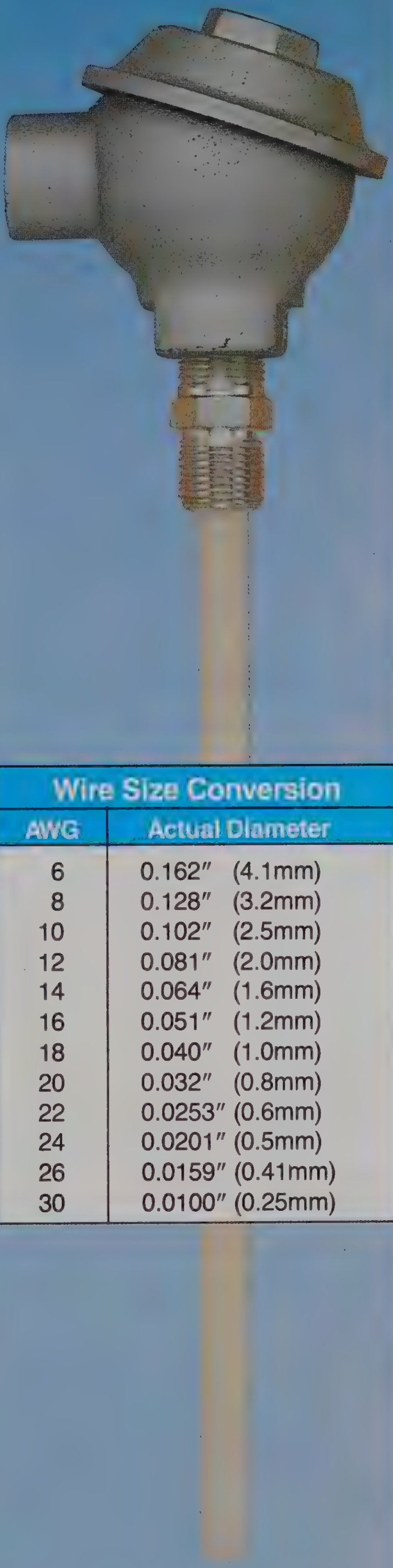
High Temperature

Platinum Thermocouple and Ceramic Protection Tube

- Up to 3000°F (1648°C) Rating
- Oxidizing or Reducing Atmospheres
- Connection Head With Terminal Block


Rugged cast iron protection head
Hard-fired ceramic insulators
¼″ NPT process thread
High purity alumina protection tube

Type R, S, or B Platinum Thermocouple enclosed in a high purity alumina protection tube. Standard construction includes a cast iron NB1-2 connection head and ½″ NPT process thread. For use at temperatures up to 3000°F (1648°C). Elements are insulated by a double bore high purity hard-fired alumina insulator.



Part Number	Thermocouple Calibration	AWG Wire Size	Protection Tube OD	Insulator OD	Price 12″ Length	Price add'l 6 in.
RAT-30-12″	Pt vs Pt 13% Rh	30	¼	⅛	**$133**	**$ 37**
RAT-24-12″	Pt vs Pt 13% Rh	24	¼	⅛	**213**	**67**
RAT-20-12″	Pt vs Pt 13% Rh	20	⅜	3⁄16	**388**	**139**
SAT-30-12″	Pt vs Pt 10% Rh	30	¼	⅛	**133**	**37**
SAT-24-12″	Pt vs Pt 10% Rh	24	¼	⅛	**213**	**67**
SAT-20-12″	Pt vs Pt 10% Rh	20	⅜	3⁄16	**388**	**139**
BAT-30-12″	Pt 6% Rh vs Pt 30% Rh	30	¼	⅛	**133**	**37**
BAT-24-12″	Pt 6% Rh vs Pt 30% Rh	24	¼	⅛	**213**	**67**
BAT-20-12″	Pt 6% Rh vs Pt 30% Rh	20	⅜	3⁄16	**388**	**139**

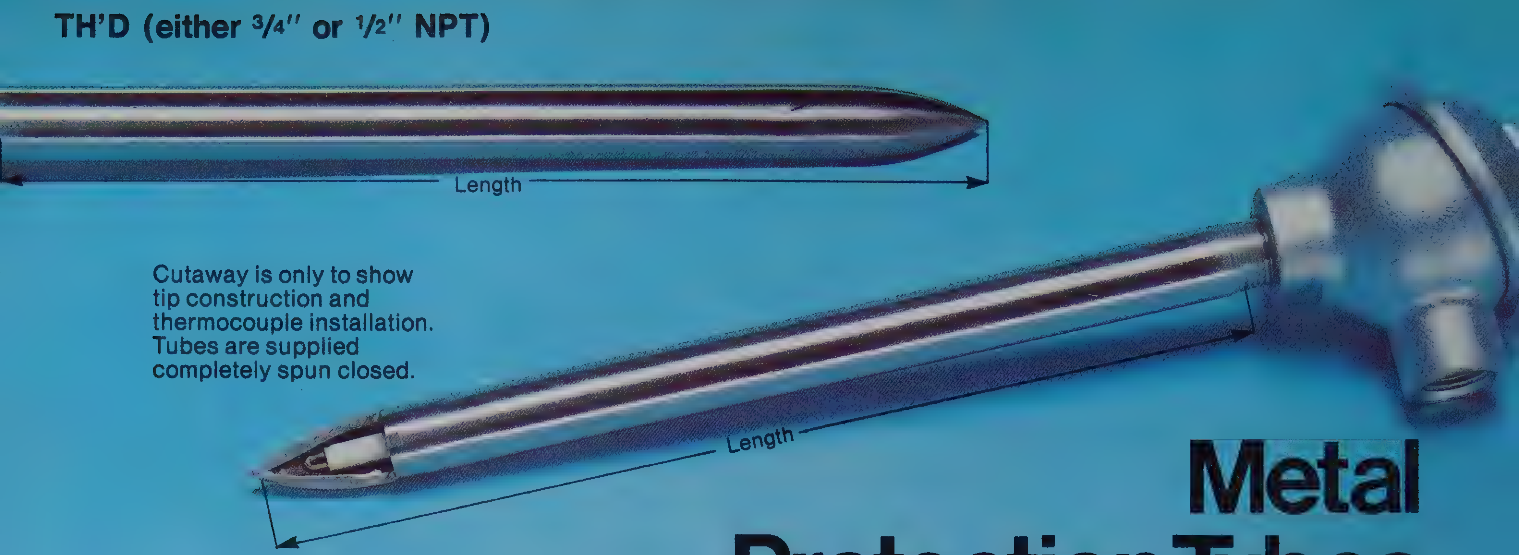
NOTE: Alumina tube shipped separately to avoid breakage.

Wire Size Conversion

AWG	Actual Diameter
6	0.162″ (4.1mm)
8	0.128″ (3.2mm)
10	0.102″ (2.5mm)
12	0.081″ (2.0mm)
14	0.064″ (1.6mm)
16	0.051″ (1.2mm)
18	0.040″ (1.0mm)
20	0.032″ (0.8mm)
22	0.0253″ (0.6mm)
24	0.0201″ (0.5mm)
26	0.0159″ (0.41mm)
30	0.0100″ (0.25mm)

REPLACEMENT ELEMENTS FOR PROBES SHOWN ABOVE

Type of Element	AWG Wire Size	Insulator 99.7% + Al_2O_3	Type S PT-PT/10%Rh	Type R PT-PT/13%Rh	Type B PT/6%Rh-PT/30%Rh	Price 12″ Length	Price add'l (in.)
Bare Wires (No Insulators)	20	None	Bare-20-S-12	Bare-20-R-12	Bare-20-B-12	**$295**	**$20**
	24	None	Bare-24-S-12	Bare-24-R-12	Bare-24-B-12	**120**	**8**
	30	None	Bare-30-S-12	Bare-30-R-12	Bare-30-B-12	**40**	**3**
Double-Hole Round Insulators	20	XDH-20	XDH-20-S-12	XDH-20-R-12	XDH-20-B-12	**$305**	**$21**
	24	XDH-24	XDH-24-S-12	XDH-24-R-12	XDH-24-B-12	**130**	**9**
	30	XDH-30	XDH-30-S-12	XDH-30-R-12	XDH-30-B-12	**50**	**4**



Cutaway is only to show tip construction and thermocouple installation. Tubes are supplied completely spun closed.

Metal Protection Tubes

Nominal 3/4" Schedule 40 Black Steel Pipe (.824 I.D. x 1.050 O.D.)

THREAD		CAT. NO.	LENGTH	PRICE
3/4"	—	PTBS-12	12"	$28
3/4"	—	PTBS-18	18"	31
3/4"	—	PTBS-24	24"	33

Nominal 1/2" Schedule 40 Black Steel Pipe (.622 I.D. x .840 O.D.)

THREAD		CAT. NO.	LENGTH	PRICE
1/2"	—	PTBS-12	12"	$25
1/2"	—	PTBS-18	18"	28
1/2"	—	PTBS-24	24"	30

Nominal 3/4" Schedule 40-304 SS Pipe (.824 I.D. x 1.050 O.D.)

THREAD		CAT. NO.	LENGTH	PRICE
3/4"	—	PTSS-12	12"	$43
3/4"	—	PTSS-18	18"	52
3/4"	—	PTSS-24	24"	60

Nominal 1/2" Schedule 40-304 SS Pipe (.622 I.D. x .840 O.D.)

THREAD		CAT. NO.	LENGTH	PRICE
1/2"	—	PTSS-12	12"	$40
1/2"	—	PTSS-18	18"	48
1/2"	—	PTSS-24	24"	57

Technical DATA

Male NPT thread on one end, spun closed on the other end.

Material	Max. Continuous Operating Temp.	Mech. Strength Cold	Mech. Strength Hot	Applications	Remarks
304SS	1650°F	Excellent	Fair	Food processing, Dairy products, Petroleum prod., mild acids, alkalies.	Embrittles in 800°F to 1400°F range.
Black Steel	1200°F	Excellent	Good	Molten Babbit, Tin, Lead and Magnesium	Low cost

Mounting Flanges and Bushings with standard N.P.T. thread available upon request. *Consult factory for pricing.*

Discount Schedule:

1-10 units	Net
11-24 units	10%
25-100 units	20%
101-500 units	30%
501-1000 units	40%
1001-5000 units	50%

Quantity discount applies to like tubes. Other sizes, materials and configurations by quotation.

Expanded Product Line!

Miniature and Standard Protection Tubes

- 316 Stainless Steel
- Inconel 600

OMEGA's Miniature and Standard Protection Tubes are available in 316 Stainless steel and Inconel 600 nickel alloy. Tubes are available either open at both ends or with one end closed. Standard length available from stock is 6 inches; however, practically any length tube is available on short delivery.

OMEGA's protection tubes are intended for use with OMEGA's fine or heavy gage thermocouples and ceramic insulators, as well as OMEGA's standard thermocouples made from OMEGACLAD™ thermocouple wire. These items are shown in Section B of this catalog. Bare wire thermocouples can be insulated using OMEGATITE™ ceramic insulators shown on Pages **B-11** and **B-12** as well as the insulators used in replacement elements described on Page **B-13**.

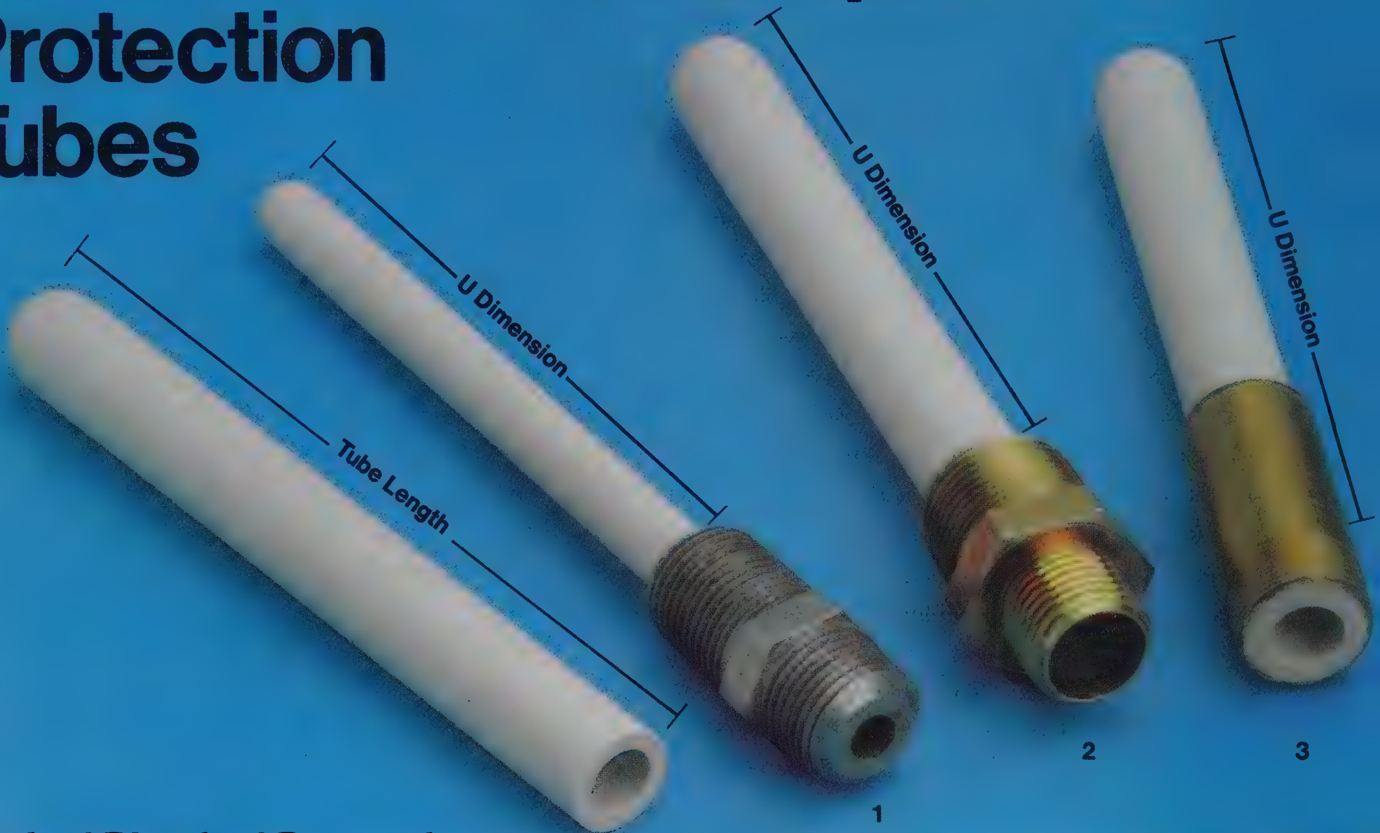
OMEGA's protection tubes can be conveniently secured into pipes, vessels, and chambers by using OMEGALOK™ compression fittings shown on Page **A-12**.

Material	O.D. inches	I.D. inches	Price first 6 inches	Additional price per inch	Closed end price addition	Catalog Number
316 Stainless Steel	1/16	.052	**$5.00**	**$ .80**	**$2.00**	SS-116 -☐-☐
	1/8	.070	**5.00**	**.80**	**2.00**	SS-18 -☐-☐
	3/16	.132	**5.00**	**.80**	**2.00**	SS-316 -☐-☐
	1/4	.194	**5.00**	**.80**	**2.00**	SS-14 -☐-☐
	5/16	.260	**5.00**	**.80**	**2.00**	SS-516 -☐-☐
	3/8	.320	**5.00**	**.80**	**2.00**	SS-38 -☐-☐
	7/16	.370	**5.00**	**.80**	**2.00**	SS-716 -☐-☐
	1/2	.430	**5.00**	**.80**	**2.00**	SS-12 -☐-☐
"600" Inconel	1/6	.052	**$6.00**	**$1.10**	**$2.00**	INC-116-☐-☐
	1/8	.070	**6.00**	**1.10**	**2.00**	INC-18 -☐-☐
	3/16	.132	**6.00**	**1.10**	**2.00**	INC-316-☐-☐
	1/4	.210	**6.00**	**1.10**	**2.00**	INC-14 -☐-☐
	5/16	.247	**6.00**	**1.10**	**2.00**	INC-516-☐-☐
	3/8	.305	**6.00**	**1.10**	**2.00**	INC-38 -☐-☐
	7/16	.367	**7.50**	**1.25**	**2.00**	INC-716-☐-☐
	1/2	.430	**8.50**	**1.40**	**2.00**	INC-12 -☐-☐

Material
Outside diameter code
Length in inches, 6″ is standard
Closed one end "CL", Open "O"

Ordering example: SS-516-8½-CL is a Closed end 5/16″ O.D. 316 Stainless Steel Protection Tube, 8½ inches long.
Price = **$5.00** + **$2.40** + **$2.00** = **$9.40.**

Ceramic Thermocouple Protection Tubes



Standard Fittings

Typical Physical Properties

Properties	Omegatite 450	Omegatite 300
Composition	99.8% Al_2O_3	85% Mullite 15% Glass
Water Absorption	0.00	0.00
Specific Gravity	3.85	2.8
Gas Permeability	Gas Tight	Gas Tight
Compressive Strength (psi)	>300,000	>190,000
Tensile Strength (psi)	30,000	18,000
Transverse Strength (psi)	55,000	27,000
Coefficient of Linear Thermal Expansion		
24°C– 250°C	6.2×10^{-6}	3.3×10^{-6}
24°C– 500°C	7.4×10^{-6}	4.0×10^{-6}
24°C–1000°C	8.5×10^{-6}	5.0×10^{-6}
24°C–1500°C	9.8×10^{-6}	. . . .
Approximate Thermal Conductivity		
(BTU) (in)/(hr) (ft²) (°F) 24°C	230	40
800°C	60	25
Maximum Service Temperature	1950°C 3540°F	1750°C 3180°F
Dielectric Constant (1MC)	9.29	5.80
Dielectric Strength (volts/mil)	230	250
Volume Resistivity (ohm cm)	10^{13}	10^{13}
Te Value	800°C	800°C
Hardness (Mohs Scale)	9	7.5
Fabrication Methods	Cast	Cast

Typical Chemical Analyses

	AL_2O_3	SIO_2	MgO	Na_2O	CaO	Fe_2O_3	GA_2O_3	TIO_2	MnO	ZrO_2	K_2O
Omegatite 450	99.8	.070	.050	.005	.030	.025	.009	.004	.001	. . . .	. . . .
Omegatite 300	60.0	38.0	.200	.200	.100	.500	. . . .	.500	. . . .	. . . .	.700

Note: All properties are average for test specimens. Tests were performed according to ASTM specifications.

Ceramic Thermocouple Protection Tubes

		Tube Length*	PTRA [OMEGATITE 450]		PTRM [OMEGATITE 300]	
Inside dia.	Outside dia.		Catalog Number	Price	Catalog Number	Price
1/16″	1/8″	12″	PTRA 11618-12	$ 27	PTRM 11618-12	$14
		18″	PTRA 11618-18	40	PTRM 11618-18	21
		24″	PTRA 11618-24	54	PTRM 11618-24	28
5/64″	5/32″	12″	PTRA 564532-12	27	PTRM 564532-12	14
		18″	PTRA 564532-18	40	PTRM 564532-18	21
		24″	PTRA 564532-24	54	PTRM 564532-24	28
5/32″	1/4″	12″	PTRA 53214-12	27	PTRM 53214-12	14
		18″	PTRA 53214-18	40	PTRM 53214-18	21
		24″	PTRA 53214-24	54	PTRM 53214-24	28
3/16″	1/4″	12″	PTRA 31614-12	27	PTRM 31614-12	14
		18″	PTRA 31614-18	40	PTRM 31614-18	21
		24″	PTRA 31614-24	54	PTRM 31614-24	28
3/16″	5/16″	12″	PTRA 316516-12	27	PTRM 316516-12	14
		18″	PTRA 316516-18	40	PTRM 316516-18	21
		24″	PTRA 316516-24	54	PTRM 316516-24	28
1/4″	3/8″	12″	PTRA 1438-12	27	PTRM 1438-12	14
		18″	PTRA 1438-18	40	PTRM 1438-18	21
		24″	PTRA 1438-24	54	PTRM 1438-24	28
5/16″	7/16″	12″	PTRA 516716-12	32	PTRM 516716-12	14
		18″	PTRA 516716-18	48	PTRM 516716-18	21
		24″	PTRA 516716-24	64	PTRM 516716-24	28
5/16″	1/2″	12″	PTRA 51612-12	27	PTRM 51612-12	14
		18″	PTRA 51612-18	40	PTRM 51612-18	21
		24″	PTRA 51612-24	54	PTRM 51612-24	28
3/8″	1/2″	12″	PTRA 3812-12	29	PTRM 3812-12	14
		18″	PTRA 3812-18	43	PTRM 3812-18	21
		24″	PTRA 3812-24	57	PTRM 3812-24	28
7/16″	11/16″	12″	PTRA 7161116-12	29	PTRM 7161116-12	14
		18″	PTRA 7161116-18	43	PTRM 7161116-18	21
		24″	PTRA 7161116-24	57	PTRM 7161116-24	28
1/2″	3/4″	12″	PTRA 1234-12	28	PTRM 1234-12	16
		18″	PTRA 1234-18	42	PTRM 1234-18	23
		24″	PTRA 1234-24	56	PTRM 1234-24	30
5/8″	7/8″	12″	PTRA 5878-12	40	PTRM 5878-12	35
		18″	PTRA 5878-18	60	PTRM 5878-18	52
		24″	PTRA 5878-24	80	PTRM 5878-24	69
3/4″	1″	12″	PTRA 341-12	40	PTRM 341-12	32
		18″	PTRA 341-18	60	PTRM 341-18	49
		24″	PTRA 341-24	80	PTRM 341-24	65
7/8″	1 1/8″	12″	PTRA 78118-12	50	PTRM 78118-12	49
		18″	PTRA 78118-18	75	PTRM 78118-18	73
		24″	PTRA 78118-24	100	PTRM 78118-24	98
1″	1 1/4″	12″	PTRA 1114-12	50	PTRM 1114-12	45
		18″	PTRA 1114-18	75	PTRM 1114-18	68
		24″	PTRA 1114-24	100	PTRM 1114-24	91
5mm	7mm	12″	PTRA 5mm 7mm-12	29	PTRM 5mm 7mm-12	16
		18″	PTRA 5mm 7mm-18	43	PTRM 5mm 7mm-18	23
		24″	PTRA 5mm 7mm-24	58	PTRM 5mm 7mm-24	30

***LENGTH:** The tube lengths shown are standard lengths for a tube without any fittings. See table below for lengths with fittings.

LENGTHS WITH FITTINGS

Fitting	Fitting Length	ASSEMBLY LENGTH	"U" Dimension
1/2″ x 1/2″ NPT	1 3/4″	Tube plus 1″	Tube minus 3/4″
1/2″ x 3/4″ NPT	1 3/4″	Tube plus 1″	Tube minus 3/4″
7/8 x 27NS	2″	Tube Length	Tube minus 3/4″

("U" dimension from base of threads.)

Special lengths available upon request. To price special lengths use next higher 6″ price.

Important Ordering Notes

FITTINGS: When ordering tube with fitting specify the fitting after the catalog number.

1. 1/2″ x 1/2″ NPT; fits tubes from 1/4″ to 1/2″ OD.
2. 1/2″ x 3/4″ NPT; fits tubes from 3/8″ to 3/4″ OD.
3. 7/8″ x 27NS Brass Ferrule 2″ long; fits 11/16″ OD tube ONLY.

For tube with any of the above fittings add $30 to the price of the tube.

Discount Schedule:

1-10 units	Net	25-100 units	20%
11-24 units	10%	101-500 units	30%

Quantity discount applies to like tubes. Other sizes, materials, and configurations by quotation.

THERMOCOUPLE INSULATORS

Tolerances

The diameter and "out of roundness" of **OMEGA'S** insulators is plus or minus 2 percent. The straightness is at least 1/32 inch for each six inch length. The following table lists the maximum recommended wire diameter which should be used with six inch sections. Closer tolerances are permissible with shorter sections but the minimum clearance tolerance is ±3% or .005 inch, whichever is greater.

Bore Diameter	1/8"	3/32"	5/64"	1/16"	3/64"	1/32"	0.020	1/64"	0.005
Maximum Wire Diameter	.102	.064	.064	.040	.032	.025	.016	.010	.003

Assortment of **OMEGA'S** miniature insulators showing relative size. Sizes up to 1/4 inch o.d. are available from stock.

Omegatite 450

This is an impervious, recrystallized, pure alumina ceramic containing over 99.8% Al_2O_3. It has the most superior gas and vacuum tightness and electrical insulating properties at elevated temperatures. It is non-reactive and recommended for use with platinum, as well as tungsten and molybdenum thermocouple alloys. The maximum service temperature is 3540°F.

Omegatite 350

This is an impervious, recrystallized pure alumina ceramic containing over 99% Al_2O_3. It has superior gas and vacuum tightness and electrical insulating properties at elevated temperatures. It is non-reactive and compatible with tungsten and molybdenum thermocouple alloys. The maximum service temperature is 3450°F.

Omegatite 200

This material is recommended for most thermocouple applications. It consists of a mullite type ceramic capable of withstanding temperatures up to 3000°F.

Typical Physical Properties

Properties	Omegatite 450	Omegatite 350	Omegatite 200
Constitution	99.8% Al_2O_3	99% Al_2O_3	80% Mullite 20% Glass
Water Absorption	0.00	0.00	0.00
Specific Gravity	3.85	3.7	2.4
Gas Permeability	Gas Tight	Gas Tight	Gas Tight
Compressive Strength (psi)	300,000	300,000	100,000
Tensile Strength (psi)	30,000	30,000	14,000
Transverse Strength (psi)	55,000	55,000	20,000
Coefficient of Linear Thermal Expansion			
24°C– 250°C	6.2×10^{-6}	6.6×10^{-6}	....
24°C– 500°C	7.4×10^{-6}	7.3×10^{-6}	....
24°C–1000°C	8.5×10^{-6}	8.1×10^{-6}	....
24°C–1500°C	9.8×10^{-6}	....	....
Approximate Thermal Conductivity (BTU/ft²/hr/°F/in)			
24°C	230	210	16
800°C	60	50	....
Maximum Service Temperature	1950°C 3540°F	1900°C 3450°F	1650°C 3000°F
Dielectric Constant (1MC)	9.29	8.61	4.95
Dielectric Strength (volts/mil)	230	250	250
Volume Resistivity (ohm cm)	10^{13}	10^{13}	....
Te Value	800°C	1100°C	....
Hardness (Mohs Scale)	9	9	7
Fabrication Methods	Cast or Extrusion	Cast or Extrusion	Extrusion

Typical Chemical Analyses

	Al_2O_3	SIO_2	MgO	Na_2O	Ca	Fe_2O_3	GA_2O_3	TIO_2	MnO	ZrO_2	K_2O
Omegatite 450	99.8	.070	.050	.005	.030	.025	.009	.004	.001	....	....
Omegatite 350	99.0	.7	.07	.05	.030	.07	....	....	....	....	....
Omegatite 200	55.4	42.0	.04	.5	.1	.8	....	.5	....	....	.7

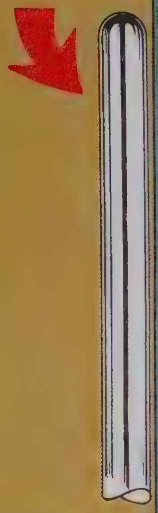
Note: All properties are average for test specimens. Tests were performed according to ASTM specifications.

THERMOCOUPLE INSULATORS

PRICE LIST

WIDE RANGE OF SIZES AVAILABLE

Single hole ceramics with Closed End are available. See pages B-9, B-10



OMEGA® thermocouple insulators are supplied in a wide range of sizes. Sizes up to 1/4 inch o.d. are available from stock. Other sizes, styles and lengths by quotation.

IMPORTANT ORDERING NOTES

LENGTHS ■ Prices quoted are for standard six (6) inch length ceramics. Other sizes and styles are available on special order.

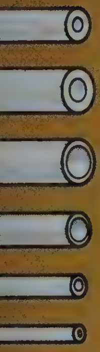
DISCOUNT SCHEDULE ■ 1-10 units net; 11-24 units 10%; 25-100 units 20%; 101-500 units 30%; 501 units & up 40%, Quantity discount applies to total order within each grade. Each "unit" is a standard stocked six (6) inch length.

SPECIAL SIZES OR SHAPES ■ Orders for special sizes, shapes and tolerances should be explicit and accompanied by a sketch or print. Single hole ceramics with closed end are available. Consult Sales Department.

PRICES ■ All prices are subject to change

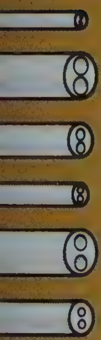
METRIC DIMENSIONS ALSO AVAILABLE! CONSULT SALES DEPARTMENT

SINGLE HOLE ROUND INSULATORS



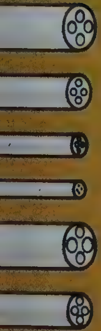
OUTSIDE DIAMETER (INCHES)	INSIDE DIAMETER (INCHES)	OMEGATITE 450		OMEGATITE 350		OMEGATITE 200	
		CATALOG NUMBER	PRICE PER* SIX INCH LENGTH	CATALOG NUMBER	PRICE* PER SIX INCH LENGTH	CATALOG NUMBER	PRICE* PER SIX INCH LENGTH
1/4	1/8	ORX 1814	$6	ORA 1814	$5	ORM 1814	$3
1/4	3/32	ORX 33214	6	ORA 33214	5	ORM 33214	3
1/4	1/16	ORX 11614	6	ORA 11614	5	ORM 11614	3
3/16	3/32	ORX 332316	6	ORA 332316	5	ORM 332316	3
3/16	1/16	ORX 116316	6	ORA 116316	5	ORM 116316	3
1/8	1/16	ORX 11618	6	ORA 11618	5	ORM 11618	3
1/16	1/32	ORX 132116	6	ORA 132116	5	ORM 132116	3
1/32	.020	ORX 020132	8	ORA 020132	6	ORM 020132	3

TWO HOLE ROUND INSULATORS



OUTSIDE DIAMETER (INCHES)	INSIDE DIAMETER (INCHES)	OMEGATITE 450		OMEGATITE 350		OMEGATITE 200	
		CATALOG NUMBER	PRICE PER* SIX INCH LENGTH	CATALOG NUMBER	PRICE* PER SIX INCH LENGTH	CATALOG NUMBER	PRICE* PER SIX INCH LENGTH
1/4	5/64	TRX 56414	$6	TRA 56414	$5	TRM 56414	$3
1/4	1/16	TRX 11614	6	TRA 11614	5	TRM 11614	3
3/16	1/16	TRX 116316	6	TRA 116316	5	TRM 116316	3
1/8	.040	TRX 04018	6	TRA 04018	5	TRM 04018	3
1/8	1/32	TRX 13218	6	TRA 13218	5	TRM 13218	3
1/8	.020	TRX 02018	6	TRA 02018	5	TRM 02018	3
1/16	1/64	TRX 164116	6	TRA 164116	5	TRM 164116	3
3/64	.010	TRX 010364	6	TRA 010364	5	TRM 010364	3
1/32	.005	TRX 005132	8	TRA 005132	6	TRM 005132	3

FOUR HOLE ROUND INSULATORS



OUTSIDE DIAMETER (INCHES)	INSIDE DIAMETER (INCHES)	OMEGATITE 450		OMEGATITE 350		OMEGATITE 200	
		CATALOG NUMBER	PRICE PER* SIX INCH LENGTH	CATALOG NUMBER	PRICE* PER SIX INCH LENGTH	CATALOG NUMBER	PRICE* PER SIX INCH LENGTH
1/4	1/16	FRX 11614	$ 6	FRA 11614	$5	FRM 11614	$3
3/16	3/64	FRX 364316	6	FRA 364316	5	FRM 364316	3
3/16	1/32	FRX 132316	6	FRA 132316	5	FRM 132316	3
1/8	.020	FRX 02018	6	FRA 02018	5	FRM 02018	3
1/16	1/64	FRX 164116	6	FRA 164116	5	FRM 164116	4
1/32	.005	FRX 005132	10	FRA 005132	9	FRM 005132	7

*All stock insulators are six inches in length. Other sizes, styles and lengths by quotation.

Insulators

Ceramic Bead, Teflon, and Fiberglass Sleeving

Single Hole Round (SH)

$22/100

Material Max. Temp.	Insulator Part No.	Used With Wire Size AWG/Inch	Dimension*	
			Length (in.)	O.D. (in.)
Mullite 1600°C	SH-1-8	8/0.128	1.0	1/4
	SH-1-14	14/0.064	1.0	3/16
	SH-1-20	20/0.032	1.0	1/8
	SH-1-24	24/0.020	1.0	1/16

Double Hole Round (DH)

$22/100

Material Max. Temp.	Insulator Part No.	Used With Wire Size AWG/Inch	Dimension*	
			Length (in.)	O.D. (in.)
Mullite 1600°C	DH-1-8	8/0.128	1.0	15/32
	DH-1-14	14/0.064	1.0	9/32
	DH-1-20	20/0.032	1.0	5/32
	DH-1-24	24/0.020	1.0	1/8

Single Hole Fish Spine (FS)

$3/100

Material Max. Temp.	Insulator Part No.	Used With Wire Size AWG/Inch	Dimension*	
			Length (in.)	O.D. (in.)
Steatite 1200°C	FS-260-8**	8/0.128	0.26	0.26
	FS-200-14**	14/0.064	0.20	0.20
	FS-110-20	20/0.032	0.11	0.11

**Now in FAST-STACK package. $9/500 pcs; $11/M.

Double Hole Oval (OV)

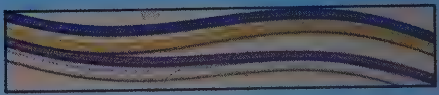
$22/100

Material Max. Temp.	Insulator Part No.	Used With Wire Size AWG/Inch	Dimension*		
			Length (in.)	O.D. (in.)	Thick (in.)
Mullite 1600°C	OV-1-8	8/0.128	1.0	15/32	0.275
	OV-1-14	14/0.064	1.0	5/16	0.203
	OV-1-20	20/0.032	1.0	11/64	0.118

*All dimensions given are nominal figures only.

Fiberglass Sleeving

Fiberglass sleeving is ideal for insulating bare wire in applications not exceeding 900°F (482°C).



Gage / Color	20	24	26	28	30
Black	FBGS BK 20	FBGS BK 24	FBGS BK 26	FBGS BK 28	FBGS BK 30
Yellow	FBGS Y 20	FBGS Y 24	FBGS Y 26	FBGS Y 28	FBGS Y 30
Blue	FBGS B 20	FBGS B 24	FBGS B 26	FBGS B 28	FBGS B 30
Purple	FBGS P 20	FBGS P 24	FBGS P 26	FBGS P 28	FBGS P 30
Red	FBGS R 20	FBGS R 24	FBGS R 26	FBGS R 28	FBGS R 30
Natural	FBGS N 20	FBGS N 24	FBGS N 26	FBGS N 28	FBGS N 30

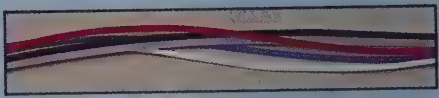
25¢/ft 10 to 99 ft

15¢/ft 100 ft and up

10 ft minimum

Teflon Tubing

Teflon tubing is used for insulating wires in moist or corrosive environments where temperatures do not exceed 450°F (233°C).



Gage / Color	20	24	26	28	30
Black	TF-BK 20	TF-BK 24	TF-BK 26	TF-BK 28	TF-BK 30
Blue	TF-B 20	TF-B 24	TF-B 26	TF-B 28	TF-B 30
Purple	TF-P 20	TF-P 24	TF-P 26	TF-P 28	TF-P 30
Red	TF-R 20	TF-R 24	TF-R 26	TF-R 28	TF-R 30
White	TF-W 20	TF-W 24	TF-W 26	TF-W 28	TF-W 30

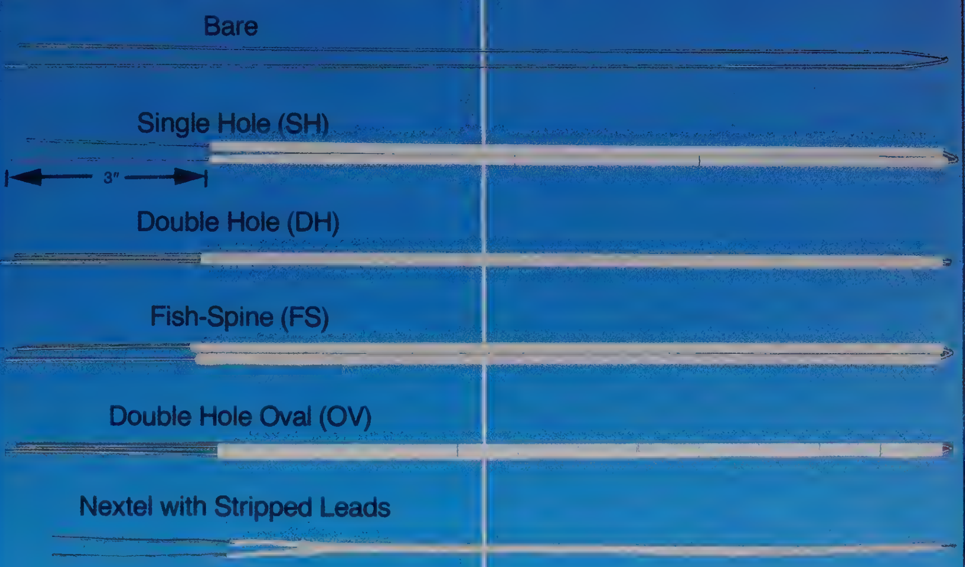
35¢/ft 10 to 99 ft

25¢/ft 100 ft and up

10 ft minimum

Thermocouple Elements

OMEGA's thermocouples are precise temperature measuring elements and are made of the highest grade materials available. They are carefully assembled according to the highest standards set by the industry. OMEGA's thermocouples are checked against standard temperature-millivolt curves to assure calibration accuracy and must match the accepted performance curves of the standard ANSI accuracy limits.



IRON-CONSTANTAN (J) CHROMEL-ALUMEL (K) COPPER-CONSTANTAN (T) CHROMEL-CONSTANTAN (E)

BASE METAL THERMOCOUPLES (12″ LONG PLUS 3″ LEADS STANDARD)*

Type of Element	AWG Wire Size	Insulator Used	Type J Iron-Constantan	Price 12″ Length	Price Add'l 6″ or Fraction	Type K Chromel-Alumel	Price 12″ Length	Price Add'l 6″ or Fraction	Type T Copper-Constantan	Price 12″ Length	Price Add'l 6″ or Fraction	Type E Chromel-Constantan	Price 12″ Length	Price Add'l 6″ or Fraction
Bare Wires (No Insulators)	8	None	Bare-8-J-12	$ 6	$2	Bare-8-K-12	$ 7	$2	Bare-8-T-12	$ 6	$2	Bare-8-E-12	$ 7	$2
	14		Bare-14-J-12	6	2	Bare-14-K-12	6	2	Bare-14-T-12	6	2	Bare-14-E-12	6	2
	20		Bare-20-J-12	6	2	Bare-20-K-12	6	2	Bare-20-T-12	6	2	Bare-20-E-12	6	2
	24		Bare-24-J-12	6	2	Bare-24-K-12	6	2	Bare-24-T-12	6	2	Bare-24-E-12	6	2
With Single Hole Round Insulators	8	SH-1-8	SH-1-8-J-12	12	3	SH-1-8-K-12	12	3	SH-1-8-T-12	12	3	SH-1-8-E-12	12	3
	14	SH-1-14	SH-1-14-J-12	11	3	SH-1-14-K-12	11	3	SH-1-14-T-12	11	3	SH-1-14-E-12	11	3
	20	SH-1-20	SH-1-20-J-12	11	3	SH-1-20-K-12	11	3	SH-1-20-T-12	11	3	SH-1-20-E-12	11	3
	24	SH-1-24	SH-1-24-J-12	11	3	SH-1-24-K-12	11	3	SH-1-24-T-12	11	3	SH-1-24-E-12	11	3
With Double Hole Round Insulators	8	DH-1-8	DH-1-8-J-12	12	3	DH-1-8-K-12	12	3	DH-1-8-T-12	12	3	DH-1-8-E-12	12	3
	14	DH-1-14	DH-1-14-J-12	11	3	DH-1-14-K-12	11	3	DH-1-14-T-12	11	3	DH-1-14-E-12	11	3
	20	DH-1-20	DH-1-20-J-12	11	3	DH-1-20-K-12	11	3	DH-1-20-T-12	11	3	DH-1-20-E-12	11	3
	24	DH-1-24	DH-1-24-J-12	11	3	DH-1-24-K-12	11	3	DH-1-24-T-12	11	3	DH-1-24-E-12	11	3
With Single Hole Fish-Spine Insulators	8	FS-.260-8	FS-.260-8-J-12	12	3	FS-.260-8-K-12	12	3	FS-.260-8-T-12	12	3	FS-.260-8-E-12	12	3
	14	FS-.200-14	FS-.200-14-J-12	11	3	FS-.200-14-K-12	11	3	FS-.200-14-T-12	11	3	FS-.200-14-E-12	11	3
	20	FS-.110-20	FS-.110-20-J-12	11	3	FS-.110-20-K-12	11	3	FS-.110-20-T-12	11	3	FS-.110-20-E-12	11	3
With Double Hole Oval Insulators	8	OV-1-8	OV-1-8-J-12	12	3	OV-1-8-K-12	12	3	OV-1-8-T-12	12	3	OV-1-8-E-12	12	3
	14	OV-1-14	OV-1-14-J-12	11	2	OV-1-14-K-12	11	3	OV-1-14-T-12	11	3	OV-1-14-E-12	11	3
	20	OV-1-20	OV-1-20-J-12	11	2	OV-1-20-K-12	11	3	OV-1-20-T-12	11	3	OV-1-20-E-12	11	3

*Three inch (3″) leads are for terminal connections. Unless ordered unassembled for replacement purposes, leads are trimmed at final assembly.

Optional Lengths Available

When ordering, change the last digits (-12) to actual length desired in inches and fractions.

NEW! NEXTEL CERAMIC INSULATION THERMOCOUPLE ELEMENTS

12″ LONG WITH INSULATION, PLUS ½″ STRIPPED ENDS STANDARD*

AWG Wire Size	Type K Temp. Range –300 to 2300°F	Price 12″ Length	Price Add'l 6″ or Fraction	Type E Temp. Range 32 to 1800°F	Price 12″ Length	Price Add'l 6″ or Fraction	Type J Temp. Range –300 to 1600°F	Price 12″ Length	Price Add'l 6″ or Fraction
14	XC-14-K-12	$8.00	$2.00	XC-14-E-12	$8.00	$2.00	XC-14-J-12	$8.00	$2.00
20	XC-20-K-12	7.00	1.50	XC-20-E-12	7.00	1.50	XC-20-J-12	7.00	1.50
24	XC-24-K-12	7.00	1.50	XC-24-E-12	7.00	1.50	XC-24-J-12	7.00	1.50

OPTIONAL LENGTHS

*When ordering, change the last digits (-12) to show actual length in inches.

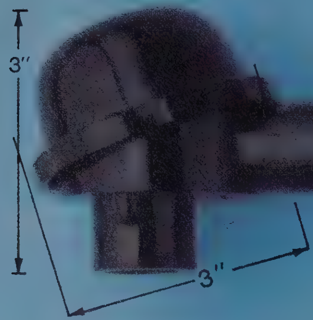
Standard is a general purpose bead welded, exposed junction thermocouple. Temperature limitation is type thermocouple material. Nextel ceramic insulation continuous rating is 2600°F, short term rating 3000°F.

Maximum Temperature Ratings*	
XC	2300°F
SH	1600°C
DH	1600°C
FS	1200°C
OV	1600°C

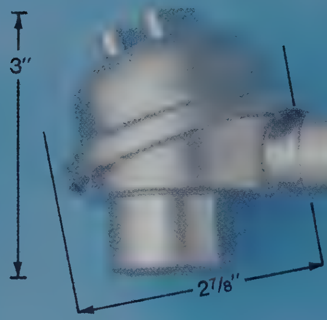
*Insulation only. Check operating limits of wire.

Thermocouple Heads

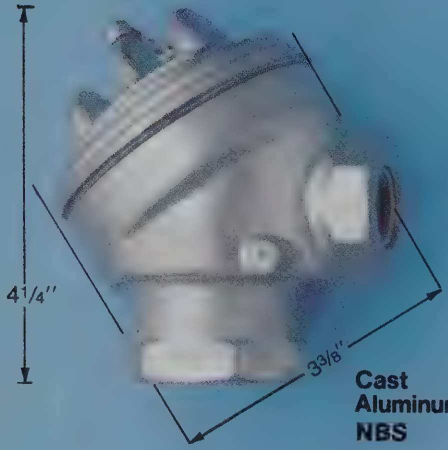
Connection Head



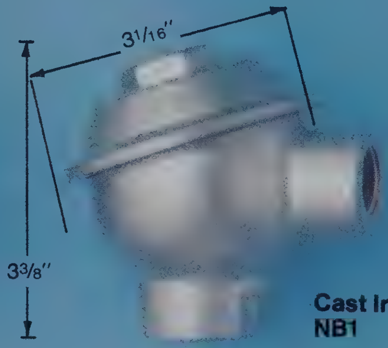
Nylon
NBN



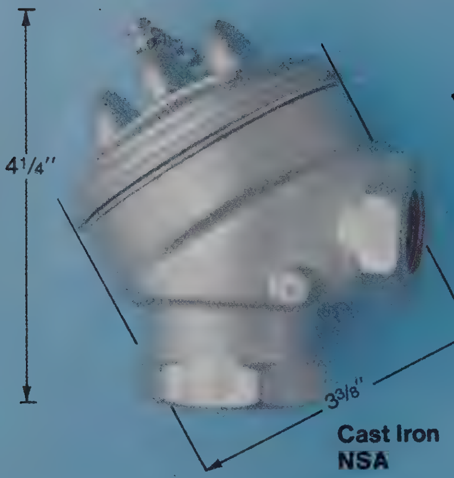
Die Cast
Aluminum
NBB



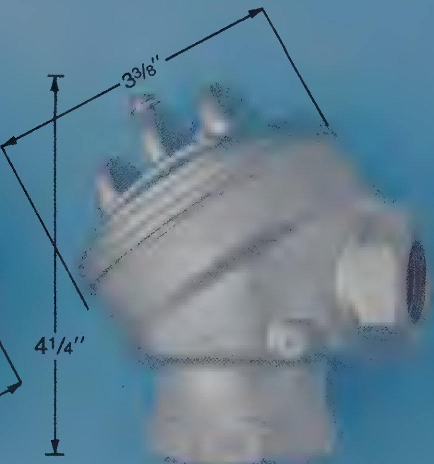
Cast
Aluminum
NBS



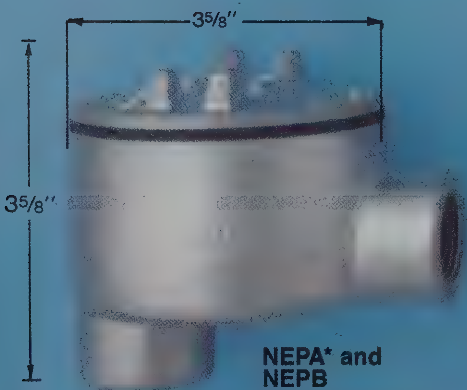
Cast Iron
NB1



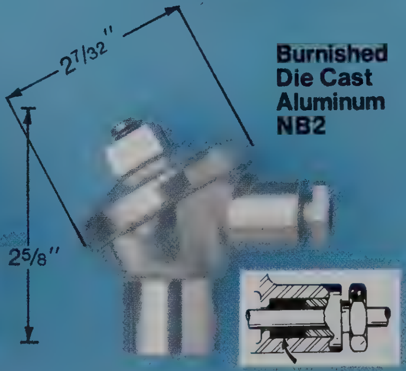
Cast Iron
NSA



Cast Iron
NSB



NEPA* and
NEPB
Explosion Proof



Burnished
Die Cast
Aluminum
NB2

Rubber Compression fitting or ½" NPT thread when nut is removed

Material	Type	Cat. No.	Price Per Piece
Nylon	NBN	NBN-0 NBN-2 NBN-4	$19 22 24
Die Cast Aluminum	NBB	NBB-0 NBB-2 NBB-4	$23 26 29
Cast Aluminum	NBS	NBS-0 NBS-2 NBS-4	$25 29 31
Cast Iron	NB1	NB1-0 NB1-2 NB1-4	$23 26 28
Cast Iron	NSA	NSA-0 NSA-2 NSA-4	$22 25 27
	NSB	NSB-0 NSB-2 NSB-4	$22 25 27
	NSC	NSC-0 NSC-2 NSC-4	$22 25 27
Cast Aluminum Body and Cap	NEPA	NEPA-0 NEPA-2 NEPA-4	$39 41 43
	NEPB	NEPB-0 NEPB-2 NEPB-4	$43 45 47
Cast Iron with Aluminum Cap	NEP-T	NEP-TX NEP-TO NEP-T2 NEP-T4	$70 50 52 54
Burnished Die Cast Aluminum	NB2	NB2-0 NB2-2 NB2-4	$23 26 28

***NOTE:** The use of explosion proof heads does not imply that a complete assembly is either explosion proof or intrinsically safe. It is the user's responsibility to determine suitability of materials for an installation.

Terminal Blocks for Connection Heads

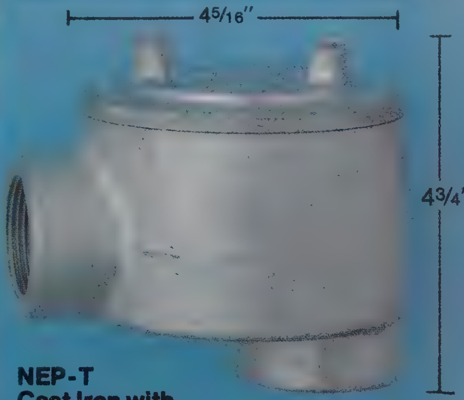
Terminals	Weight ounces	Tapped Openings Protection tube entry	 Extension wire entry	Features
0 = no terminal block 2 = single element 4 = duplex element max. 14 gage wire	3 4 5	½" NPT	Supplied with nylon bushing for plastic covered extension wire to .240"-.400" O.D.	• Easy accessibility to terminal block • Suitable for use in ambient temperatures to 250°F • Moisture and dust-resistant • Ideal for chemical plant use • Excellent corrosion resistance • Very light weight
0 = no terminal block 2 = single element 4 = duplex element max. 14 gage wire	6 7 8	½" NPT	½" NPT	• Good corrosion resistance • Light weight • Bayonet cover readily removed without tools • Easy accessibility to terminal block • Moisture and dust-resistant
0 = no terminal block 2 = single element 4 = duplex element max. 8 gage wire	15 18 20	½" NPT	½" NPT	• Good corrosion resistance • Light weight • Cover, equipped with safety chain, readily removed without tools • Moisture and dust-resistant
0 = no terminal block 2 = single element 4 = duplex element max. 14 gage wire	22 23 24	½" NPT	½" NPT	• Rugged construction • Screw cover with inside thread • Moisture and dust-resistant • Ideal for outdoor use
0 = no terminal block 2 = single element 4 = duplex element max. 8 gage wire	42 46 48	½" NPT	¾" NPT	• Rugged construction • Screw cover with inside thread • Moisture and dust-resistant • Ideal for outdoor use • Standard OMEGA heavy-duty head (NSC is not shown, but in appearance is similar to the NSA and NSB heads.)
0 = no terminal block 2 = single element 4 = duplex element max. 8 gage wire	40 44 46	¾" NPT	¾" NPT	
0 = no terminal block 2 = single element 4 = duplex element max. 8 gage wire	36 40 42	1" NPT	¾" NPT	
0 = no terminal block 2 = single element 4 = duplex element max. 8 gage wire	16½ 17¾ 18¼	¾" NPT	¾" NPT	• Explosion-Proof Head • Rated for: Class I, Groups C, D Class II, Groups E, F, G Class III • Screw cover with inside thread • Moisture and dust-resistant • Ideal for outdoor use
0 = no terminal block 2 = single element 4 = duplex element max. 8 gage wire	21½ 22¾ 23¼	½" NPT	½" NPT	
Contains mounting plates for OMEGA 2-wire transmitter 0 = no terminal block 2 = single element 4 = duplex element max. 8 gage wire	76 75 76¼ 76¾	½" NPT	½" NPT	• Explosion-proof enclosure for OMEGA 2-wire transmitter • Rated for: Class I, Group C, D Class II, Group E, F, G Class III • Screw cover with inside thread • Moisture and dust resistant
0 = no terminal block 2 = single element 4 = duplex element max. 12 gage wire	5 6 6½	½" NPT Standard ¼" NPT available Add "¼ NPT" after Cat. #	½" NPT internal thread w/compression fitting nut and rubber ferrule for ⅛" to ¼" O.D. wire or tube	• Small and lightweight • Good corrosion resistance • Gasketed, weather resistant • Burnished finish • Safety chain on cover

CERAMIC BLOCK WITH NICKEL PLATED BRASS TERMINALS FOR NB2 HEAD. FOR 12 GAGE WIRE MAXIMUM			
CAT. NO. If Ordered Separately	**TERMINALS**	**WEIGHT**	**PRICE**
CH49	2 = single	1½ oz.	$4
CH50	4 = duplex	2 oz.	6

CERAMIC BLOCKS WITH BRASS TERMINALS FOR TYPE NSA, NSB, NSC & NBS CONNECTION HEADS FOR MAX. 8 GAGE WIRE			
CAT NO. If Ordering Separately	**TERMINALS**	**WEIGHT**	**PRICE**
CH47	2 = single	3 ozs.	$6
CH48	4 = duplex	4½ ozs.	8

Improved Design

CERAMIC BLOCKS WITH BRASS TERMINALS FOR TYPE NBN, NBI & NBB CONNECTION HEADS FOR MAX. 14 GAGE WIRE			
CAT. NO. If Ordering Separately	**TERMINALS**	**WEIGHT**	**PRICE**
CH73	2 = single	1¼ ozs.	$3
CH74	4 = duplex	1¾ ozs.	5



NEP-T
Cast Iron with
Aluminum Cap
Explosion Proof

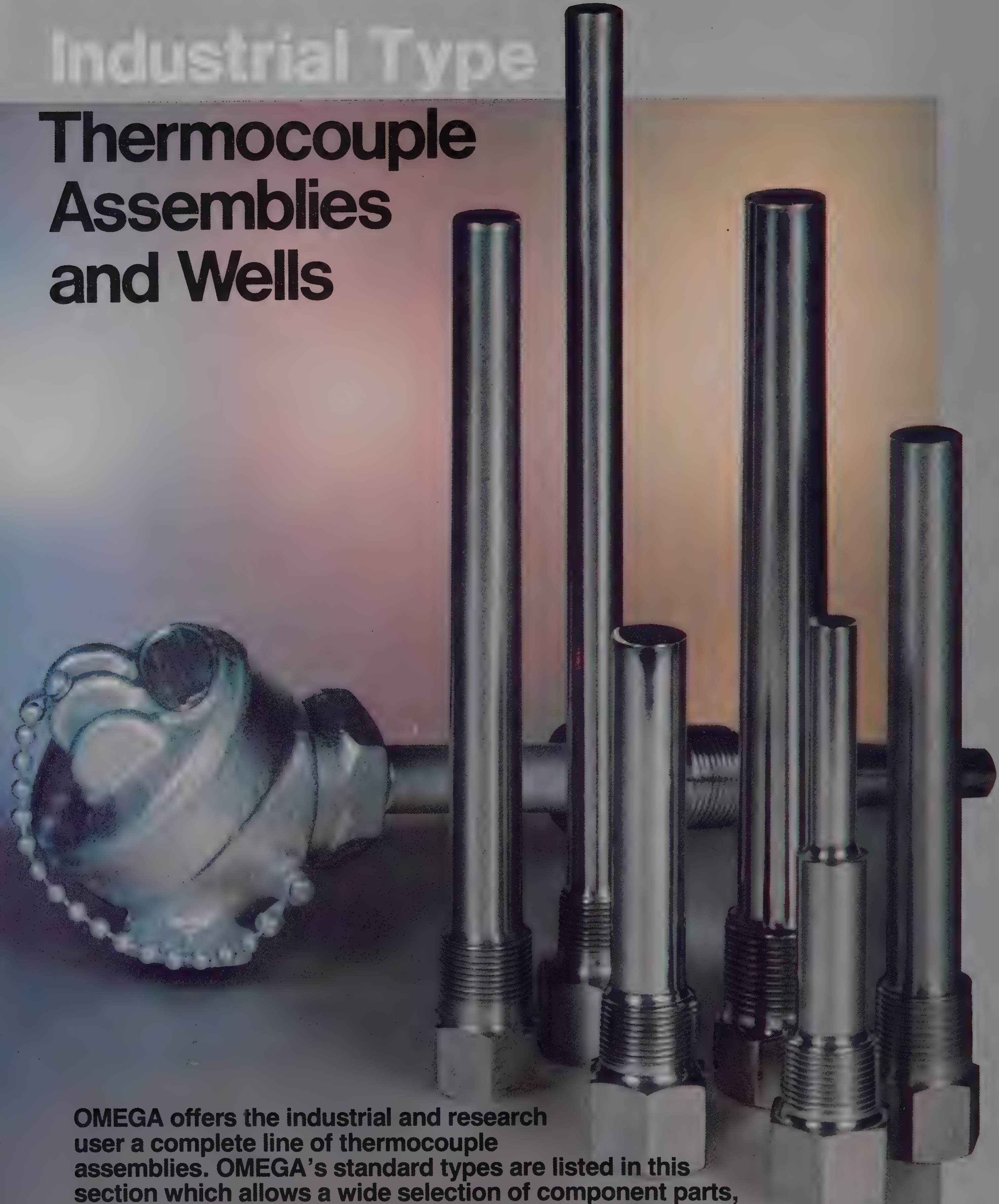
For use with 2-Wire Transmitter.

Quantity Discount Schedule

1-99	List	500-749	10%
100-249	5%	750-999	12½%
250-499	7½%	1000-up	15%

Industrial Type

Thermocouple Assemblies and Wells



OMEGA offers the industrial and research user a complete line of thermocouple assemblies. OMEGA's standard types are listed in this section which allows a wide selection of component parts, partial assemblies, and complete assemblies ready for installation.

Many other styles of components and assemblies are also available. OMEGA is always happy to quote on your special needs.

Selection of Thermowells

Material—The Longevity Factor

In general, the thermowell material chosen for the installation is governed mainly by the corrosion conditions the well will face. The high polish given to all stainless and Monel wells provides maximum corrosion resistance.

Occasionally, the material consideration is one of strength rather than corrosion resistance. For example, a stainless steel well may be required for high pressure water service instead of a brass well which would be satisfactory from a corrosion standpoint. Consult the pressure-temperature ratings given for each well type.

Wells are also available in special grades of stainless steel, Chrome-molybdenum steel, Silicone bronze, Hastelloy B & C, Nickel, Titanium, and Monel. Tantalum jackets are also available.

Connection—The Installation Factor

In these pages, you will find standard bore wells of threaded, flanged (A.S.A. and Van Stone), and socket weld types.

All threaded wells are made in easily welded or brazed materials. This is important for installations requiring seal welding or brazing. The pipe thread provides the mechanical strength, the weld or braze provides the seal.

Flanged wells (other than Van Stone type) consist of a bar stock well which is solidly welded to a top quality flange. Standard construction uses a primary "J" groove weld and a bevel groove secondary weld. The underside weld is machined to produce a clean fillet. This double welded construction eliminates the possibility of crevice corrosion since no open joints are exposed from either inside or outside the installation.

Socket weld wells are simple to install—merely weld them into place. These wells fit A.S.A. standard socket weld couplings or flanges. The resulting installation is clean and tight.

Insertion Length —The Accuracy Factor

The distance from the tip of the well to the underside of the thread, or other connection means is the insertion length (designated as "U"). For best accuracy, this length should be long enough to permit the entire temperature sensitive part of the element to project into the medium being measured. A properly installed element will project into *liquid* an amount equal to its sensitive length plus at least one inch. In air or gas, the element should be immersed its sensitive length plus at least three inches.

Thermocouples and thermistors have short sensitive lengths. They can be used with the shorter insertion length thermowells.

Bimetal thermometers, resistance thermometers, and liquid-in-glass thermometers have sensitive portions between one and two inches long. Therefore, the minimum standard insertion length of 2½" (63.5 mm) must be entirely immersed in liquid for proper accuracy.

Filled system thermometer bulbs may have sensitive portions from one to several inches in length. Determine the sensitive length of bulb before choosing an insertion length.

Above all—be sure that *dead length*, i.e.—that required to pass thru walls, pipe fittings, etc., is taken into account when choosing the necessary well insertion length.

Bore Size —The Interchangeability Factor

Almost any installation uses several types of temperature measuring sensors. The selection of a standard bore diameter can produce extreme flexibility within the plant. The same well can accommodate either thermocouple, resistance thermometer, bimetal thermometer, or test thermometer.

The bore sizes of wells shown in this handbook cover the most commonly used temperature sensing elements as follows:

0.260" (6.6 mm) Diameter Bore:	Bimetal Thermometers ¼" (6.4 mm) Stem Thermocouples—(#20 Gage) Liquid-in-glass Test Thermometers (unarmored) Other elements having 0.250" maximum diameter
0.385" (9.8 mm) Diameter Bore:	Thermocouples (#14 Gage) Liquid-in-glass Test Thermometers (armored) Other elements having 0.35" (9.5 mm) maximum diameter

Tapered or Straight Wells
The Velocity Rating Factor

Tapered shank wells provide greater stiffness for the same sensitivity. The higher strength-to-weight ratio gives these wells a higher natural frequency than the equivalent length straight shank wells, thus permitting operation at higher fluid velocity. Refer to "Velocity Ratings of Wells."

Velocity Ratings of Wells

Well failures, in many cases, are not due to the effect of pressure and temperature alone. Inadequate strength of well can be due to improper choice of wall thickness or material. OMEGA assumes no responsibility for the failure of a thermowell except as stated in the OMEGA warranty found in the front of the Temperature Measurement Handbook.

Less familiar, and more dangerous, are the *vibrational effects* to which wells are subjected. Fluid, flowing by the well, forms a turbulent wake (called the Von Karman Trail) which has a definite frequency based on the diameter of the well and the velocity of the fluid. It is important that the well have sufficient stiffness so that the wake frequency will never equal the natural frequency of the well itself. If the natural frequency of the well were to coincide with the wake frequency, the well will vibrate to destruction and break off in the piping.

Recommended maximum velocity rating can be found for every standard well length and material cataloged. To reduce the complexity of presenting this information, the ratings given are based on operating temperatures of 1000°F (537°C) for wells made of Carbon Steel (C-1018), A.I.S.I. 304, & A.I.S.I. 316. Values for brass wells are based on 350°F (177°C) operation. Limits for Monel wells are based on 900°F (482°C) service. Slightly higher velocity may be possible at lower temperatures.

Where single values appear in the velocity tables, these may be considered safe for water, steam, air or gas. In the shorter insertion lengths, consideration is given to the velocity pressure effect of water flowing at higher velocities. The values in parenthesis, therefore, represent safe values for water flow while the unbracketed value may be used for steam, air, gas and similar density fluids.

It should be pointed out that the values given are intended primarily as a guide. To be safe, check each well with your own calculation.

If you have operating conditions requiring special well designs, our Engineering Staff is available to assist you in all cases. OMEGA assumes no responsibility for the failure of a well except for its repair or replacement. *See OMEGA's Warranty.*

Flanged Thermowells

When ordering FLANGED Thermowells, be sure to specify the flange fully. USE A SKETCH or DRAWING OF THE FLANGE and specify FLANGE MATERIAL. FOR BREVITY, USE "SS" for stainless steel, "CS" for carbon steel, "FF" for flat face flanges, and "RF" for raised face flanges.

TO BE SURE THE CORRECT FLANGE IS ORDERED, CONTACT OMEGA'S **APPLICATION ENGINEERING DEPARTMENT** FOR ASSISTANCE WHEN ORDERING FLANGED THERMOWELLS.

Thermocouple Head

A Connection Heads

OMEGA's standard connection head is the Model NSA. Designed to meet virtually all industrial needs. Connection heads provide the greatest protection for the electrical terminations of the transducer and associated instrumentation while maintaining easy access to the terminals.

The threaded cover is chained and fully gasketed for completely weatherproof installations. All OMEGA connection heads are available with either a single (2 wire) or a duplex (4 wire) terminal block. Any connection head shown on pages B-15 and B-16 can be used in an OMEGA Head and Well Assembly.

B Extension Assemblies

Selection is made on the basis of operational requirements, accessibility, or avoiding direct contact with hot surfaces. Also, it is often required that the extension permit removal of the thermocouple element. For these requirements, OMEGA offers a complete line of configurations and component parts. OMEGA extensions are made of ½″ NPT standard weight steel nipples and unions.

TYPE 1—DIRECT ASSEMBLY

A Type 1 assembly is used to connect the head to a protection tube. This type is only used with metal or ceramic protection tubes that have a male thread for direct assembly to a connection head. **Specify: Type 1**

TYPE 2—NIPPLE EXTENSION

A Type 2 assembly is used to connect the head to a thermowell. The length is measured from the bottom of the head to the top of the well. Available assembled in lengths of 0″, ½″ (13 mm), 1″ (25.4 mm), 1½″ (38 mm), 2″ (51 mm), 2½″ (64 mm), 3″ (76 mm), 4″ (102 mm), and 5″ (127 mm). **Specify: Type 2-(length)**

TYPE 3—NIPPLE UNION EXTENSION

A Type 3 assembly uses a nipple and a union to connect a head with the male thread of a protection tube or fitting on a ceramic tube. Available assembled in lengths of 2″ (51 mm), 2½″ (64 mm), 3″ (76 mm), 3½″ (89 mm), 4″ (102 mm), 4½″ (114 mm), 5″ (127 mm), 6″ (152 mm), and 7″ (178 mm). **Specify: Type 3-(length)**

TYPE 4—NIPPLE UNION NIPPLE EXTENSION

A Type 4 assembly consists of a union and two nipples, one threading into the head and one into the thermowell. This type permits easy removal of the head and element from the well. Available assembled in lengths between 2″ (51 mm) and 12″ (305 mm). **Specify: Type 4-(length)**

NON-STANDARD EXTENSIONS

Pricing—Add $2 for each additional 6″ (152 mm), or fraction of 6″ (152 mm) up to 48″ (1219 mm). Over 48″ (1219 mm), consult Sales Department. Example: Type 2-12 indicates Type 2 extension with 12″ (304 mm) length. Pricing for standard Type 2 is $5, additional 7″ (178 mm) nipple length is $4, total price $9.

C Thermocouple Elements

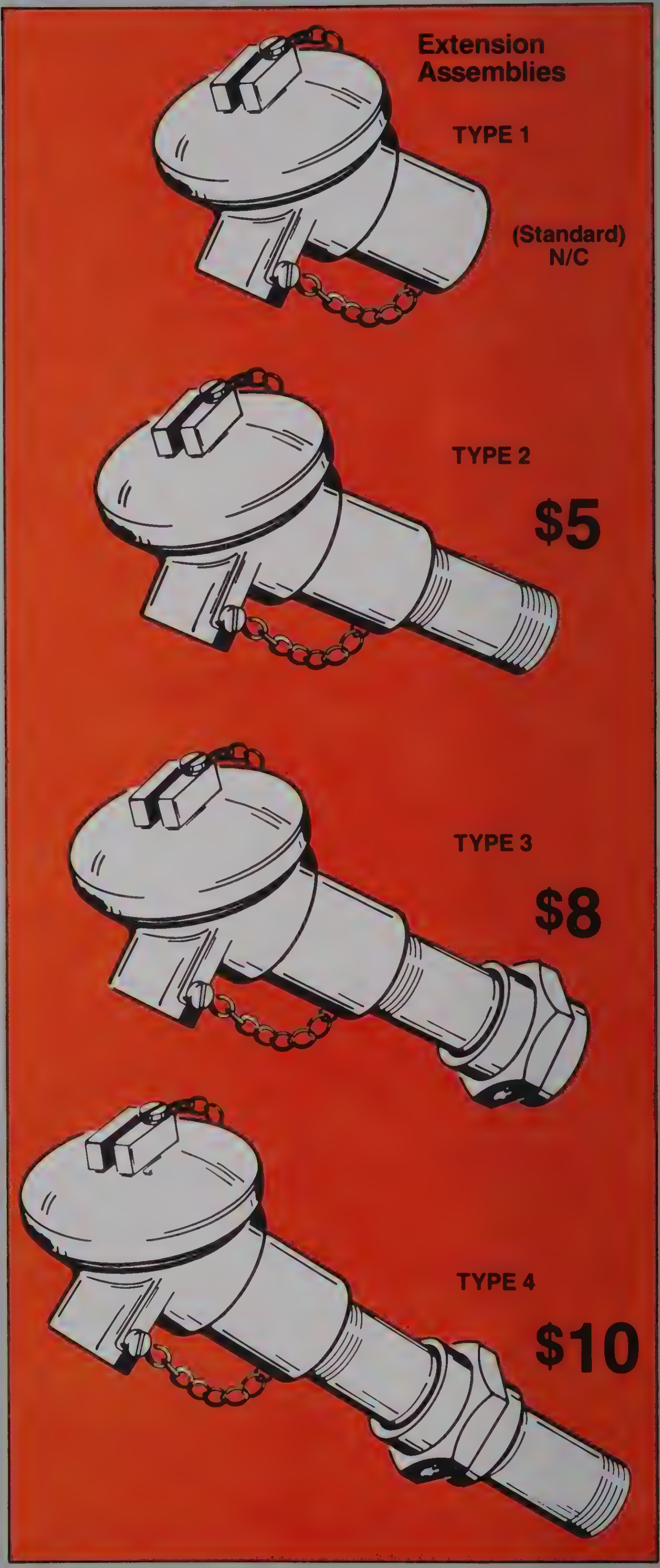
OMEGA offers a complete line of thermocouple probes and elements, varying in diameter, type of junction, and configuration. Select elements from page B-14. A complete engineering group, staffed in depth by competent and experienced personnel, is ready to consult on any specific requirement employing thermocouples.

D Thermowells

OMEGA offers the most complete line of standardized thermowells in the industry. Wells made of special materials are available upon request.

CAP and CHAIN Options: For Brass cap, add $4 to price and add suffix —CC (Brass) to the end of the catalog number.

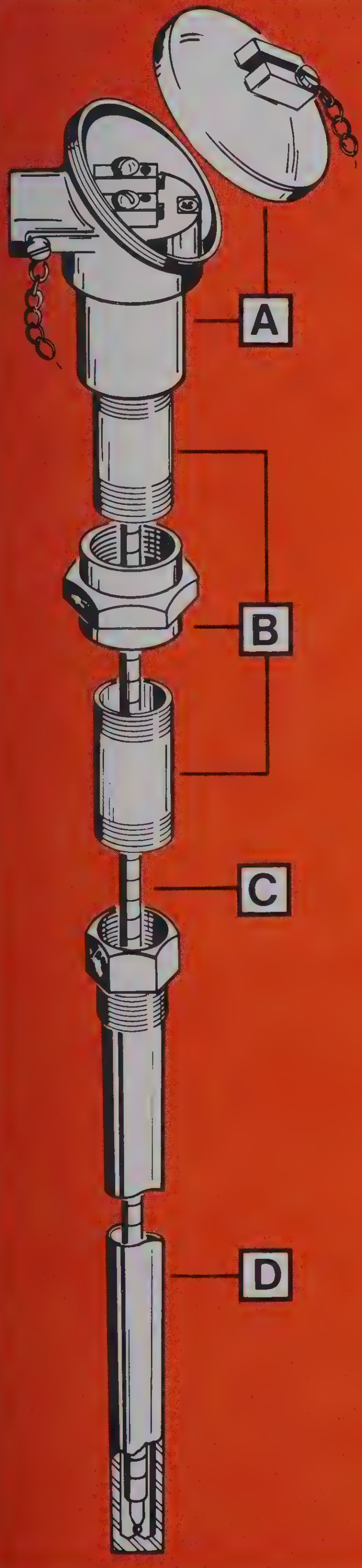
For 304SS cap, add $7 to price and add suffix—CC (304SS) to the end of the catalog number.



and Well Assemblies

HOW TO ORDER AND ESTIMATE PRICE OF THE ASSEMBLY

Code **HWA** signifies head and well assembly



NSA-2 rugged cast-iron connection head is standard. See pages B-15 and B-16 for other available styles.

Type **4-6″** extension. See page B-19 for additional extension styles.

Thermocouple Element **DH-1-14-K-16″.** SELECT elements from page B-11 or metal sheathed type elements from pages B-3 to A-11.

Thermowell **1″-385S-U7½-304SS.** Other available wells are shown on pages B-21 to B-36.

How to Match Probe Length with the Insertion Length of the Thermowell

To assure a correct fit between the thermocouple assembly, dial thermometer or RTD and the thermowell into which it is inserted, OMEGA recommends that both the probe assembly and the thermowell be ordered at the same time if possible.

Most thermowells have female NPT threads for accepting and securing the male NPT pipe fitting of the inserted probe. Due to NPT (pipe thread) tolerances and torque variations during assembly, the probe may be set at various depths in the thermowell. For example, for a ½″ NPT thread, these depth variations can be as much as ⅜″ (9.5 mm) to ⅝″ (15.9 mm). Ordering from OMEGA as a complete assembly avoids these variations.

When ordering replacement thermowells, the above variations should be considered and care should be taken to allow for them during assembly.

1. When ordering a complete assembly from this section, start with catalog description HWA, **OMEGA WILL ALWAYS CHECK YOUR CATALOG NO. AND PRICING.**

2. List the connection head desired. Type NSA-2 is threaded for ½″ NPT protection tube and has a ¾″ (19 mm) NPT extension wire entry. Type NSA-2 is standard with OMEGA. If desired, other head styles and sizes are available. They are listed on pages B-15 and B-16.

3. Specify the extension type from those listed on page B-19 and list extension length in inches and fractions; i.e., 4-6 signifies a type 4 extension that is 6″ (152 mm) long.

4. Specify thermocouple element from page B-14 and list, i.e., DH-1-14-K-16 (element) represents a 14 gage type K element (Chromel-Alumel) having 2 hole insulators with an O.D. of 0.281″ (7.1 mm). The length selected is 16″ (406 mm).

NOTE: Besides the elements listed on page B-14 OMEGA offers a number of special element constructions. Elements can also be made from thermocouple wire and OMEGACLAD™ listed in Section H. For dual element assemblies or other special element probes, consult Sales Department or send sketch.

5. List thermowell selected by giving catalog number from those listed on pages B-21 to B-36. In the example, a type 1″-385S-U7½-304 stainless steel well is designated. This denotes a straight 304 stainless steel bar stock 1″ (25.4 mm) connection size threaded type well which has a 7½″ (190 mm) "U" dimension, and a bore of 0.385″ (9.8 mm) to accommodate ⅜″ (9.5 mm) diameter elements.

COMPLETE CATALOG DESCRIPTION OF ASSEMBLY

HWA/NSA-2/4-6/DH-1-14-K-16/1″-385S-U7½-304SS

PRICE IS:

NSA-2 (HEAD)	**$25**
TYPE 4-6 (EXTENSION)	**10**
DH-1-14-K-16 (ELEMENT)	**14**
1″-385S-U7½-304SS (WELL)	**48**
TOTAL PRICE FOR COMPLETE ASSEMBLY	**$97**

Series 260L

Standard Threaded Well for ¼″ Diameter Elements

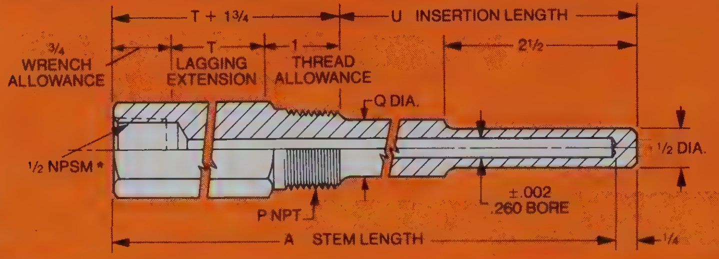
Application:
Standard Length, ¼″ Stem, Bimetal thermometers; #20 gage thermocouple elements; unarmored liquid-in-glass test thermometers. Other temperature sensing elements having .252 in. maximum diameter.

Connection Size:
½″, ¾″ and 1″ NPT are standard. Other thread sizes are available upon request.

Materials:
Brass (ASTM B-16); Carbon Steel (C-1018); Stainless Steel A.I.S.I. 304 & A.I.S.I. - 316; Monel. Wells are available also in special materials, prices on request.

Cap & Chain
Prices listed on Page B-19

Series 260L — Lagging Extension Type



All dimensions are in inches.

*NPSM internal pipe thread will accept both NPT and NPS male threads.

Ext. Th'd P	Type Number	Stem Lgth. A	Insert. Lgth. U	Lag. Ext. T	Shank Dia. Q	Materials & Prices Stainless St. 304	Stainless St. 316	Carbon Steel	Brass
½″ NPT	½″-260L -U 2½ ☐	6	2½	2	—	$ 26.50	$ 36.00	$20.00	$20.00
	-U 4½ ☐	9	4½	3	⅝	39.50	53.00	31.50	31.50
	-U 7½ ☐	12	7½	3	″	48.00	65.00	41.00	41.00
	-U10½ ☐	15	10½	3	″	69.00	93.00	53.00	53.00
	-U13½ ☐	18	13½	3	″	82.50	111.00	63.50	63.50
	-U19½ ☐	24	19½	3	″	106.00	143.00	74.00	74.00
¾″ NPT	¾″-260L -U 2½ ☐	6	2½	2	—	26.50	36.00	20.00	20.00
Most Popular Sizes ▶	-U 4½ ☐	9	4½	3	¾	39.50	53.00	31.50	31.50
	-U 7½ ☐	12	7½	3	″	48.00	65.00	41.00	41.00
	-U10½ ☐	15	10½	3	″	69.00	93.00	53.00	53.00
	-U13½ ☐	18	13½	3	″	82.50	111.00	63.50	63.50
	-U19½ ☐	24	19½	3	″	106.00	143.00	74.00	74.00
1″ NPT	1″-260L -U 2½ ☐	6	2½	2	—	36.50	49.00	26.50	26.50
	-U 4½ ☐	9	4½	3	⅞	48.00	65.00	34.50	34.50
	U 7½ ☐	12	7½	3	″	60.00	80.00	46.00	46.00
	-U10½ ☐	15	10½	3	″	83.00	111.50	61.00	61.00
	-U13½ ☐	18	13½	3	″	97.00	130.50	71.50	71.50
	-U19½ ☐	24	19½	3	″	132.50	164.00	83.00	83.00

Material - 304 S.S., Carbon Steel, etc.
Insertion length dimension
Bore size - inch
External thread - NPT

Maximum Fluid Velocity – feet per second (see Section on Velocity — Page B-18)

Well Type	Material	Insertion Length - "U" 2½	4½	7½	10½	13½	16½	19½	22½
½″ - 260S and ½″ - 260L	Brass	207 (59.3)	75.5 (32.2)	27.3 (19.7)	13.9	8.4	5.6	4.1	3.0
	Carbon Steel	290 (106)	105 (59)	38.2 (36.3)	19.4	11.8	7.8	5.7	4.2
	A.I.S.I. 304 & 316	300 (148)	109 (82.2)	39.5	20.1	12.2	8.1	5.9	4.4
	Monel	261 (118)	95 (65.5)	34.4	17.5	10.5	7.1	5.2	3.8
¾″ - 260S and ¾″ - 260L	Brass	207 (59.3)	89.1 (39.8)	32.2 (23.9)	16.4	9.9	6.6	4.8	3.6
	Carbon Steel	290 (106)	123 (71.2)	44.9 (42.7)	22.8	13.8	9.3	6.7	4.9
	A.I.S.I. 304 & 316	300 (148)	128 (99.3)	46.4	23.6	14.3	9.6	6.9	5.1
	Monel	261 (118)	112 (79.8)	40.6	20.7	12.4	8.3	6.1	4.5
1″ - 260S and 1″ - 260L	Brass	207 (59.3)	102 (47.6)	37.0 (28)	18.8	11.4	7.6	5.5	4.1
	Carbon Steel	290 (106)	143 (84.3)	51.6 (50.6)	26.2	15.9	10.6	7.6	5.7
	A.I.S.I. 304 & 316	300 (148)	148 (117)	53.5	27.2	16.5	11.0	7.9	5.9
	Monel	261 (118)	128 (93.3)	46.7	23.7	14.4	9.5	6.9	5.1

See Page B-22 for Pressure-Temperature Ratings.

Series 260S

Standard Threaded Well for ¼″ Diameter Elements

Application:
Standard Length, ¼″ Stem, Bimetal thermometers; #20 gage thermocouple elements; unarmored liquid-in-glass test thermometers. Other temperature sensing elements having .252 in. maximum diameter.

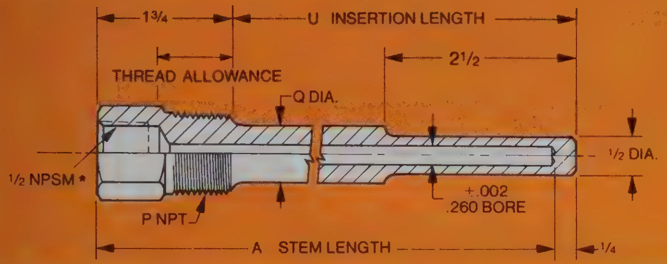
Connection Size:
½″, ¾″ and 1″ NPT are standard. Other thread sizes are available upon request.

Materials:
Brass (ASTM B-16); Carbon Steel (C-1018); Stainless Steel A.I.S.I. 304 & A.I.S.I. - 316; Monel. Wells are available also in special materials, prices on request.

Cap & Chain

Prices listed on Page B-19.

Series 260S — General Use



All dimensions are in inches.

*NPSM internal pipe thread will accept both NPT and NPS male threads.

Ext. Th'd P	Type Number	Stem Lgth. A	Insert. Lgth. U	Shank Dia. Q	Material & Prices Stainless St. 304	Stainless St. 316	Carbon Steel	Brass
	½″-260S-U 2½ □	4	2½	—	$ 22.00	$ 30.00	$16.50	$16.50
Most Popular Sizes ▶	-U 4½ □	6	4½	⅝	26.50	36.00	20.00	20.00
	-U 7½ □	9	7½	"	39.50	53.00	31.50	31.50
½″ NPT	-U10½ □	12	10½	"	48.00	65.00	41.00	41.00
	-U13½ □	15	13½	"	69.00	93.00	53.00	53.00
	-U16½ □	18	16½	"	82.50	111.00	63.50	63.50
	-U22½ □	24	22½	"	106.00	143.00	74.00	74.00
	¾″-260S-U 2½ □	4	2½	—	22.00	30.00	16.50	16.50
Most Popular Sizes ▶	-U 4½ □	6	4½	¾	26.50	36.00	20.00	20.00
	-U 7½ □	9	7½	"	39.50	53.00	31.50	31.50
¾″ NPT	-U10½ □	12	10½	"	48.00	65.00	41.00	41.00
	-U13½ □	15	13½	"	69.00	93.00	53.00	53.00
	-U16½ □	18	16½	"	82.50	111.00	63.50	63.50
	-U22½ □	24	22½	"	106.00	143.00	74.00	74.00
	1″-260S-U 2½ □	4	2½	—	29.00	35.50	22.00	22.00
Most Popular Sizes ▶	-U 4½ □	6	4½	⅞	36.50	49.00	26.50	26.50
	-U 7½ □	9	7½	"	48.00	65.00	34.50	34.50
1″ NPT	-U10½ □	12	10½	"	60.00	80.00	46.00	46.00
	-U13½ □	15	13½	"	83.00	111.50	61.00	61.00
	-U16½ □	18	16½	"	97.00	130.50	71.50	71.50
	-U22½ □	24	22½	"	132.50	164.00	83.00	83.00

Material - 304 S.S., Carbon Steel, etc.
Insertion length dimension
Bore size - inch
External thread - NPT

Pressure - Temperature rating – lbs. per sq. inch

Material	Temperature — °F 70°	200°	400°	600°	800°	1000°	1200°
Brass	5000	4200	1000	—	—	—	—
Carbon Steel	5200	5000	4800	4600	3500	1500	—
A.I.S.I. - 304	7000	6200	5600	5400	5200	4500	1650
A.I.S.I. - 316	7000	7000	6400	6200	6100	5100	2500
Monel	6500	6000	5400	5300	5200	1500	—

See Page B-21 for Maximum Fluid Velocity.

To order, please specify:
1. Complete Type Number
2. Material
3. Cap & Chain — If Desired

See ordering information — Page B-20

Series 260HL

Heavy Duty Threaded Well for ¼″ Diameter Elements

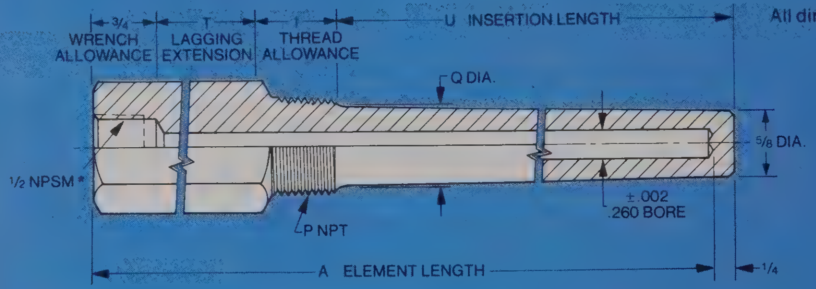
Application:
Standard length, ¼″ bimetal thermometers. #20 gage thermocouple elements. Unarmored liquid-in-glass test thermometers. Other temperature sensing elements having .252 in. maximum diameter.

Connection Size:
¾″ NPT and 1″ NPT are standard. Other thread sizes are available upon request.

Materials:
Brass (ASTM B-16); Carbon Steel (C-1018); Stainless Steel A.I.S.I. 304 & A.I.S.I. - 316; Monel. Wells are available also in special materials, prices on request.

Cap & Chain
Prices listed on page B-19.

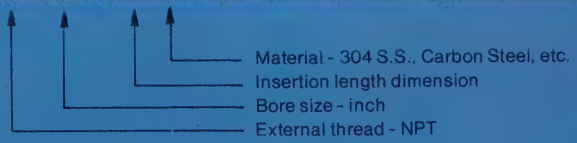
Series 260HL — Lagging Extension Type



All dimensions are in inches.

*NPSM internal pipe thread will accept both NPT and NPS male threads.

External Thread P	Type Number	Lag. Ext. T	Elem. Lgth. A	Insert. Lgth. U	Shank Dia. Q	Material & Prices Stainless St. 304	Material & Prices Stainless St. 316	Carbon Steel	Brass
¾″ NPT	¾″-260HL -U 2½☐	2	6	2½	⅞	$ 34.00	$ 46.00	$ 27.50	$ 27.50
	-U 4½☐	3	9	4½	″	50.50	68.00	42.00	42.00
	-U 7½☐	3	12	7½	″	63.50	85.50	53.50	53.50
	-U10½☐	3	15	10½	″	84.50	113.50	69.00	69.00
	-U13½☐	3	18	13½	″	102.50	138.00	83.50	83.50
	-U19½☐	3	24	19½	″	143.50	193.00	101.00	101.00
1″ NPT	1″-260HL -U 2½☐	2	6	2½	1¹⁄₁₆	42.00	56.50	29.50	29.50
	-U 4½☐	3	9	4½	″	55.50	74.50	45.50	45.50
	-U 7½☐	3	12	7½	″	68.50	92.00	58.50	58.50
	-U10½☐	3	15	10½	″	95.50	128.50	73.00	73.00
	-U13½☐	3	18	13½	″	112.00	150.50	87.00	87.00
	-U19½☐	3	24	19½	″	149.00	200.50	120.00	120.00



Material - 304 S.S., Carbon Steel, etc.
Insertion length dimension
Bore size - inch
External thread - NPT

Maximum Fluid Velocity—feet per second (see Section on Velocity—page B-18)

Well Type	Material	Insertion Length — "U" 2½	4½	7½	10½	13½	16½	19½	22½
¾″-260H and ¾″-260HL	Brass	305 (97.5)	93.8 (54.1)	33.9	17.1	10.5	7.0	5.0	3.7
	Carbon Steel	386 (175)	180 (97.2)	65.3 (58.3)	33.0	20.1	13.4	9.6	7.1
	A.I.S.I.-304 & 316	440 (243)	197 (135)	71.2	36.0	22.0	14.7	0.5	7.8
	Monel	354 (195)	155 (108)	56.1	28.4	17.3	11.6	7.5	5.6
1″-260H and 1″-260HL	Brass	354 (161)	108 (89.5)	39.4	19.8	12.2	8.1	5.8	4.3
	Carbon Steel	448 (289)	209 (161)	75.7	38.4	23.3	15.5	11.1	8.2
	A.I.S.I.-304 & 316	490 (403)	228 (225)	82.5	41.8	25.5	17.1	12.2	9.1
	Monel	410 (322)	179 (178)	65.1	33.0	20.1	13.5	8.7	6.5

See Page B-24 for Pressure-Temperature Ratings.

To order, please specify: 1. Complete Type Number
2. Material
3. Cap & Chain - If Desired

See ordering information—Page B-20

Series 260H

Heavy Duty Threaded Well for ¼″ Diameter Elements

Application:
Standard length, ¼″ bimetal thermometers. #20 gage thermocouple elements. Unarmored liquid-in-glass test thermometers. Other temperature sensing elements having .252 in. maximum diameter.

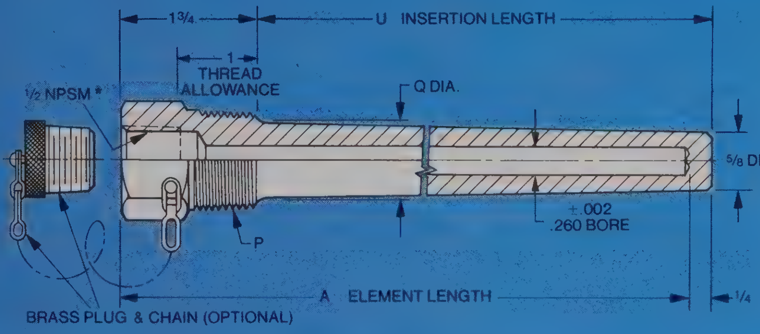
Connection Size:
¾″ NPT and 1″ NPT are standard. Other thread sizes are available upon request.

Materials:
Brass (ASTM B-16); Carbon Steel (C-1018); Stainless Steel A.I.S.I. 304 & A.I.S.I. - 316; Monel. Wells are available also in special materials, prices on request.

Cap & Chain
Prices listed on page B-19.

Series 260H — General Use

All dimensions are in inches.



*NPSM internal pipe thread will accept both NPT and NPS male threads.

External Thread P	Type Number	Elem. Lgth. A	Insert. Lgth. U	Shank Dia. Q	Material & Prices			
					Stainless St. 304	Stainless St. 316	Carbon Steel	Brass
	¾″-260H -U 2½ ☐	4	2½	⅞	$ 29.00	$ 38.50	$ 21.00	$ 21.00
Most Popular Sizes ▶	-U 4½ ☐	6	4½	″	34.00	46.00	27.50	27.50
	-U 7½ ☐	9	7½	″	50.50	68.00	42.00	42.00
¾″ NPT	-U10½ ☐	12	10½	″	63.50	85.50	53.50	53.50
	-U13½ ☐	15	13½	″	84.50	113.50	69.00	69.00
	-U16½ ☐	18	16½	″	102.50	138.00	83.50	83.50
	-U22½ ☐	24	22½	″	143.50	193.00	101.00	101.00
	1″-260H -U 2½ ☐	4	2½	1¹/₁₆	33.00	44.50	25.00	25.00
	-U 4½ ☐	6	4½	″	42.00	56.50	29.50	29.50
	-U 7½ ☐	9	7½	″	55.50	74.50	45.50	45.50
1″ NPT	-U10½ ☐	12	10½	″	68.50	92.00	58.50	58.50
	-U13½ ☐	15	13½	″	95.50	128.50	73.00	73.00
	-U16½ ☐	18	16½	″	112.00	150.50	87.00	87.00
	-U22½ ☐	24	22½	″	149.00	200.50	120.00	120.00

Material - 304 S.S., Carbon Steel, etc.
Insertion length dimension
Bore size - inch
External thread - NPT

Pressure - Temperature rating — lbs. per sq. inch

Material	Temperature — °F.						
	70°	200°	400°	600°	800°	1000°	1200°
Brass	5300	4750	1100	—	—	—	—
Carbon Steel	5950	5750	5450	5250	4000	1750	—
A.I.S.I. - 304	7800	7050	6400	6150	6000	5190	1875
A.I.S.I. - 316	7800	7800	7250	7100	6950	5800	2720
Monel	7450	6850	6150	6100	5940	1750	—

See page B-23 for Maximum Fluid Velocity.

To order, please specify: 1. Complete Type Number
2. Material
3. Cap & Chain - If Desired

See ordering information—Page B-20

Series 385L

Standard Threaded Well for ⅜″ Diameter Elements

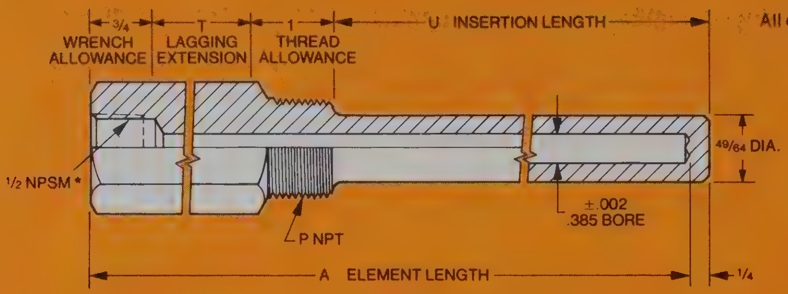
Application:
Standard length, ⅜″ stem, bimetal thermometers. #14 gage thermocouple elements. Armored liquid-in-glass test thermometers. Other temperature sensing elements having .377 in. maximum diameter.

Connection Size:
¾″ NPT and 1″ NPT are standard. Other thread sizes are available upon request.

Materials:
Brass (A.S.T.M. B-16); Carbon Steel (C-1018); A.I.S.I. 304; A.I.S.I. - 316; Monel. Wells also are available in special materials, prices on request.

Cap & Chain
Prices listed on page B-19.

Series 385L — Lagging Extension Type



All dimensions are in inches.

*NPSM internal pipe thread will accept both NPT and NPS male threads.

External Thread P	Type Number	Lag. Ext. T	Elem. Lgth. A	Insert. Lgth. U	Material & Prices			
					Stainless St. 304	Stainless St. 316	Carbon Steel	Brass
¾″ NPT	¾″-385L -U 2½ ☐	2	6	2½	$ 26.50	$ 36.00	$20.00	$20.00
	Most Popular Sizes ➧ -U 4½ ☐	3	9	4½	39.50	53.00	31.50	31.50
	-U 7½ ☐	3	12	7½	48.00	65.00	41.00	41.00
	-U10½ ☐	3	15	10½	69.00	93.00	53.00	53.00
	-U13½ ☐	3	18	13½	82.50	111.00	63.50	63.50
	-U19½ ☐	3	24	19½	106.00	143.00	74.00	74.00
1″ NPT	1″-385L -U 2½ ☐	2	6	2½	36.50	49.00	26.50	26.50
	-U 4½ ☐	3	9	4½	48.00	65.00	34.50	34.50
	-U 7½ ☐	3	12	7½	60.00	80.00	46.00	46.00
	-U10½ ☐	3	15	10½	83.00	111.50	61.00	61.00
	-U13½ ☐	3	18	13½	97.00	130.50	71.50	71.50
	-U19½ ☐	3	24	19½	132.50	164.00	83.00	83.00

Material - 304 S.S., Carbon Steel, etc.
Insertion length dimension
Bore size - inch
External thread - NPT

Maximum Fluid Velocity—feet per second (see Section on Velocity—page B-18).

Material	Insertion Length — "U"							
	2½	4½	7½	10½	13½	16½	19½	22½
Brass	290 (145)	150 (80)	54.1 (48)	27.6	16.7	11.1	8.0	6.0
Carbon Steel	326 (260)	192 (144)	69.5	35.4	20.5	14.3	10.3	7.7
A.I.S.I. - 304 & 316	349 (360)	199	71.9	36.6	21.2	14.8	10.7	8.0
Monel	316 (320)	189 (178)	68.1	34.8	20.8	14.0	10.0	7.5

See page B-26 for Pressure-Temperature Ratings.

To order, please specify: 1. Complete Type Number
2. Material
3. Cap & Chain - If Desired

See ordering information—Page B-20

Series 385S

Standard Threaded Well for ⅜" Diameter Elements

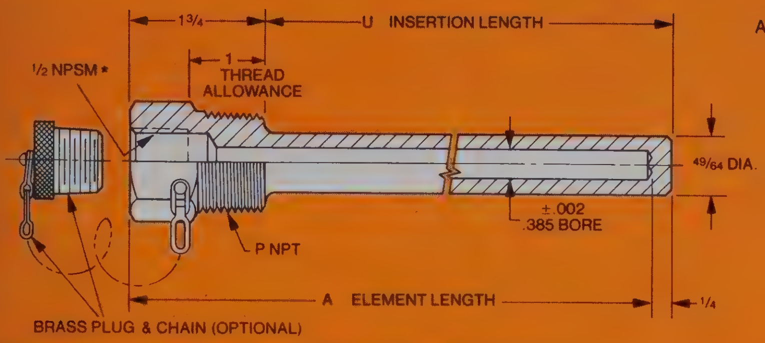
Application:
Standard length, ⅜" stem, bimetal thermometers. #14 gage thermocouple elements. Armored liquid-in-glass test thermometers. Other temperature sensing elements having .377 in. maximum diameter.

Connection Size:
¾" NPT and 1" NPT are standard. Other thread sizes are available upon request.

Materials:
Brass (A.S.T.M. B-16); Carbon Steel (C-1018); A.I.S.I. 304; A.I.S.I. - 316; Monel. Wells also are available in special materials, prices on request.

Cap & Chain
Prices listed on page B-19.

Series 385S — General Use



All dimensions are in inches.

*NPSM internal pipe thread will accept both NPT and NPS male threads.

External Thread P	Type Number	Elem. Lgth. A	Insert. Lgth. U	Material & Prices Stainless St. 304	316	Carbon Steel	Brass
	¾"-385S -U 2½ □	4	2½	$ 22.00	$ 30.00	$16.50	$16.50
Most Popular Sizes	-U 4½ □	6	4½	26.50	36.00	20.00	20.00
¾" NPT	-U 7½ □	9	7½	39.50	53.00	31.50	31.50
	-U10½ □	12	10½	48.00	65.00	41.00	41.00
	-U13½ □	15	13½	69.00	93.00	53.00	53.00
	-U16½ □	18	16½	82.50	111.00	63.50	53.50
	-U22½ □	24	22½	106.00	143.00	74.00	74.00
	1"-385S -U 2½ □	4	2½	29.00	35.50	22.00	22.00
	-U 4½ □	6	4½	36.50	49.00	26.50	26.50
	-U 7½ □	9	7½	48.00	65.00	34.50	34.50
1" NPT	-U10½ □	12	10½	60.00	80.00	46.00	46.00
	-U13½ □	15	13½	83.00	111.50	61.00	61.00
	-U16½ □	18	16½	97.00	130.50	71.50	71.50
	-U22½ □	24	22½	132.50	164.00	83.00	83.00

Material - 304 S.S., Carbon Steel, etc.
Insertion length dimension
Bore size - inch
External thread - NPT

Pressure - Temperature rating - lbs. per sq. inch

Material	Temperature — °F 70°	200°	400°	600°	800°	1000°	1200°
Brass	5000	4200	1000	—	—	—	—
Carbon Steel	5200	5000	4800	4600	3500	1500	—
A.I.S.I. 304	7000	6200	5600	5400	5200	4500	1650
A.I.S.I. 316	7000	7000	6400	6200	6100	5100	2500
Monel	6500	6000	5400	5300	5200	1500	—

See page B-25 for Maximum Fluid Velocity

To order, please specify: 1. Complete Type Number
2. Material
3. Cap & Chain - If Desired

See ordering information—Page B-20

Series 385HL

Heavy Duty Threaded Well for ⅜″ Diameter Elements

Application:
Standard length, ⅜″ Stem, bimetal thermometers. #14 gage thermocouple elements. Armored liquid-in-glass test thermometers. Other temperature sensing elements having .377 in. maximum diameter.

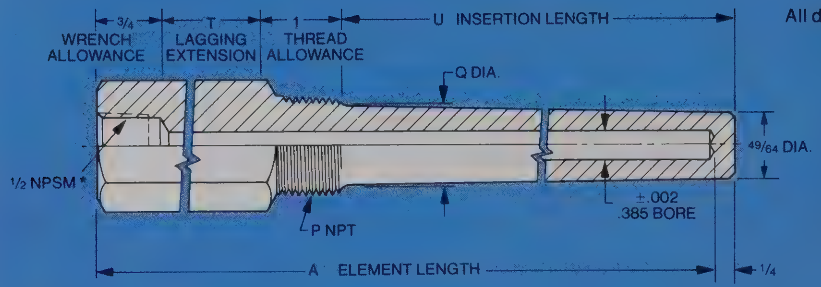
Connection Size:
1″ NPT is standard. Other thread sizes are available upon request.

Materials:
Brass (A.S.T.M. B-16); Carbon Steel (C-1018) A.I.S.I. 304; A.I.S.I. - 316; Monel. Wells also are available in special materials, prices on request.

Cap & Chain
Prices listed on Page B-19

Series 385 HL — Lagging Extension Type External Thread "P" — "1" NPT

All dimensions are in inches.



*NPSM internal pipe thread will accept both NPT and NPS male threads.

Type Number	Lag Ext. **T**	Elem. Lgth. **A**	Insert. Length **U**	Shank Dia. **Q**	Material & Prices Stainless St. 304	316	Carbon Steel	Brass
1″-385HL -U 2½☐	2	6	2½	$1\frac{1}{16}$	$ 42.00	$ 56.50	$ 29.50	$ 29.50
Most Popular Sizes -U 4½☐	3	9	4½	"	55.50	74.50	45.50	45.50
-U 7½☐	3	12	7½	"	68.50	92.00	58.50	58.50
-U10½☐	3	15	10½	"	95.50	128.50	73.00	73.00
-U13½☐	3	18	13½	"	112.00	150.50	87.00	87.00
-U19½☐	3	24	19½	"	149.00	200.50	120.00	120.00

Material - 304 S.S., Carbon Steel, etc.
Insertion length dimension
Bore size - inch
External thread - NPT

Maximum Fluid Velocity-feet per second (see Section on Velocity—Page B-18)

Material	Insertion Length — "U" 2½	4½	7½	10½	13½	16½	19½	22½
Brass	321 (150)	129 (83.5)	46.8	23.6	14.5	9.6	6.9	5.1
Carbon Steel	410 (270)	249 (150)	90.3	45.6	27.8	18.5	13.2	9.8
A.I.S.I. 304 & 316	483 (350)	272 (208)	97.3	49.7	30.4	20.3	14.5	10.7
Monel	396 (300)	214 (167)	77.5	39.2	23.8	16.0	10.3	7.7

See Page B-28 for Pressure-Temperature Ratings.

To order, please specify: 1. Complete Type Number
2. Material
3. Cap & Chain — If Desired

See ordering information—Page B-20

Series 385H

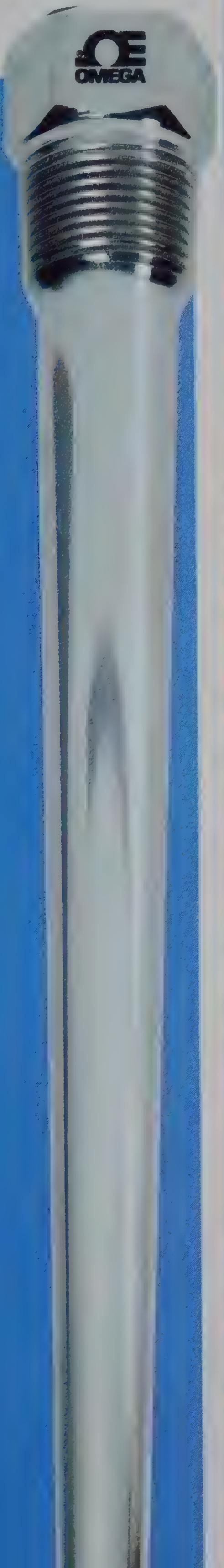
Heavy Duty Threaded Well for 3/8″ Diameter Elements

Application:
Standard length, 3/8″ Stem, bimetal thermometers. #14 gage thermocouple elements. Armored liquid-in-glass test thermometers. Other temperature sensing elements having .377 in. maximum diameter.

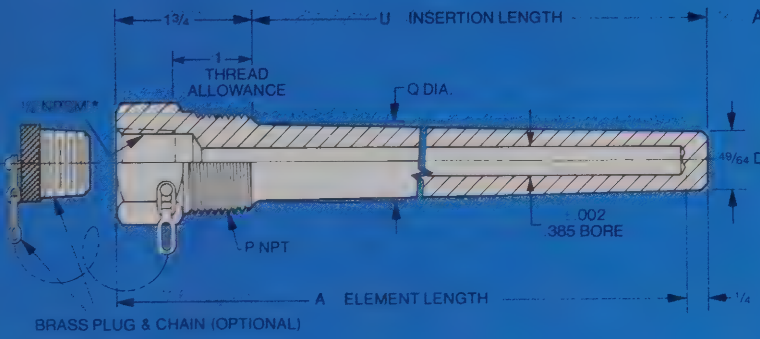
Connection Size:
1″ NPT is standard. Other thread sizes are available upon request.

Materials:
Brass (A.S.T.M. B-16); Carbon Steel (C-1018) A.I.S.I. 304; A.I.S.I. - 316; Monel. Wells also are available in special materials, prices on request.

Cap & Chain
Prices listed on Page B-19



Series 385H — General Use External Thread "P" — 1″ NPT



All dimensions are in inches.

*NPSM internal pipe thread will accept both NPT and NPS male threads.

Type Number		Elem Lgth A	Insert Lgth U	Shank Dia. Q	Material & Prices Stainless St. 304	Material & Prices Stainless St. 316	Carbon Steel	Brass
1″-385H	-U 2½ ☐	4	2½	1 1/16	$ 33.00	$ 44.50	$ 25.00	$ 25.00
Most Popular Sizes ➧	-U 4½ ☐	6	4½	″	42.00	56.50	29.50	29.50
	-U 7½ ☐	9	7½	″	55.50	74.50	45.50	45.50
	-U10½ ☐	12	10½	″	68.50	92.00	58.50	58.50
	-U13½ ☐	15	13½	″	95.50	128.50	73.00	73.00
	-U16½ ☐	18	16½	″	112.00	150.50	87.00	87.00
	-U22½ ☐	24	22½	″	149.00	200.50	120.00	120.00

Material - 304 S.S., Carbon Steel, etc.
Insertion length dimension
Bore size - inch
External thread - NPT

Pressure - Temperature rating — lbs. per sq. inch

Material	70°	200°	400°	600°	800°	1000°	1200°
Brass	5000	4200	1000	—	—	—	—
Carbon Steel	5200	5000	4800	4600	3500	1500	—
A.I.S.I. 304	7000	6200	5600	5400	5200	4500	1650
A.I.S.I. 316	7000	7000	6400	6200	6100	5100	2500
Monel	6500	6000	5400	5300	5200	1500	—

See Page B-27 for Maximum Fluid Velocity.

To order, please specify:
1. Complete Type Number
2. Material
3. Cap & Chain — If Desired

See ordering information—Page B-20

Series 385W

Socket-Weld Design Thermowells for ¼″ and ⅜″ Diameter Elements

Application:
260W series fits standard length ¼″ diameter elements.
385W series fits standard length ⅜″ diameter elements.

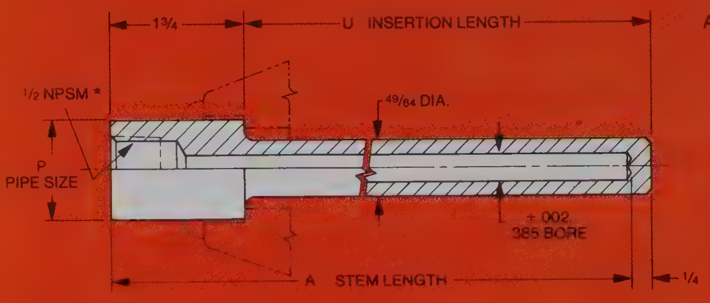
Connection:
¾″ or 1″ nominal pipe size welding shoulder fits ASA welding fittings, flanges, etc. Wells for larger pipe size fittings are available on request.

Materials:
Carbon Steel (C-1018), A.I.S.I. - 304, A.I.S.I. -316 are standard. Other materials are available on request.

Lagging Extension:
When specifying lagging extension, choose a length which will permit the use of a standard element length. (See 260L and 385L lengths)

Cap & Chain
Prices listed on Page B-19.

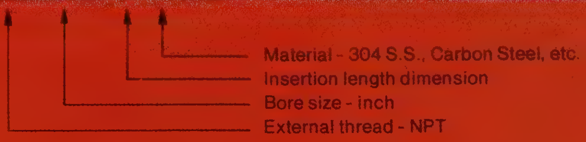
Series 385W



All dimensions are in inches.

*NPSM internal pipe thread will accept both NPT and NPS male threads.

Pipe Size P	Type Number	P	Stem Lgth. A	Insert. Lgth. U	Material & Prices Stainless St. 304	Material & Prices Stainless St. 316	Material & Prices Carbon Steel	Material & Prices Brass
¾″ Nominal (1.050 Dia.)	**¾″-385W** -U 2½☐	1.050	4	2½	$ 22.00	$ 30.00	$16.50	$16.50
	-U 4½☐	″	6	4½	26.50	36.00	20.00	20.00
	-U 7½☐	″	9	7½	39.50	53.00	31.50	31.50
	-U10½☐	″	12	10½	48.00	65.00	41.00	41.00
	-U13½☐	″	15	13½	69.00	93.00	53.00	53.00
	-U16½☐	″	18	16½	82.50	111.00	63.50	63.50
	-U22½☐	″	24	22½	106.00	143.00	74.00	74.00
1″ Nominal (1.315 Dia.)	**1″-385W** -U 2½☐	1.315	4	2½	29.00	35.50	22.00	22.00
	-U 4½☐	″	6	4½	36.50	49.00	26.50	26.50
	-U 7½☐	″	9	7½	48.00	65.00	34.50	34.50
	-U10½☐	″	12	10½	60.00	80.00	46.00	46.00
	-U13½☐	″	15	13½	83.00	111.50	61.00	61.00
	-U16½☐	″	18	16½	97.00	130.50	71.50	71.50
	-U22½☐	″	24	22½	132.50	164.00	83.00	83.00


Material - 304 S.S., Carbon Steel, etc.
Insertion length dimension
Bore size - inch
External thread - NPT

Maximum Fluid Velocity —feet per second (see Section on Velocity — Page B-18)

Well Type	Material	Insertion Length — "U" 2½	4½	7½	10½	13½	16½	22½
¾″-260W	Carbon Steel	290 (106)	123 (71.2)	44.9 (42.7)	22.8	13.8	9.3	4.9
	A.I.S.I. — 304 & 316	300 (148)	128 (99.3)	46.4	23.6	14.3	9.6	5.1
1″-260W	Carbon Steel	290 (106)	143 (84.3)	51.6 (50.6)	26.2	15.9	10.6	5.7
	A.I.S.I. - 304 & 316	300 (148)	148 (117)	53.5	27.2	16.5	11.0	5.9
¾″-385W and 1″-385W	Carbon Steel	426 (260)	192 (144)	69.5	35.4	20.5	14.3	7.7
	A.I.S.I. - 304 & 316	449 (360)	199	71.9	36.6	21.2	14.8	8.0

See Page B-30 for Pressure-Temperature Ratings.

To order, please specify: 1. Complete Type Number
2. Material
3. Cap & Chain — If Desired

See ordering information — Page B-20

Series 260W

Socket-Weld Design Thermowells for ¼″ and ⅜″ Diameter Elements

Application:
260W series fits standard length ¼″ diameter elements. 385W series fits standard length ⅜″ diameter elements.

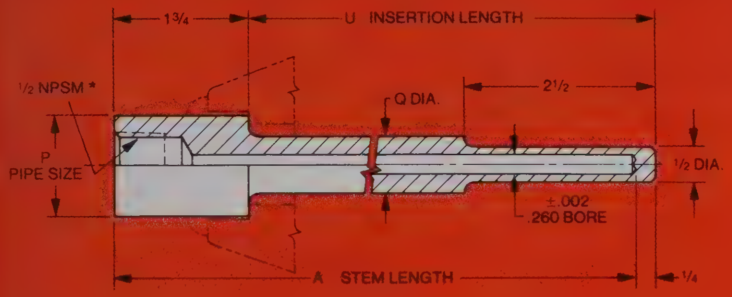
Connection:
¾″ or 1″ nominal pipe size welding shoulder fits ASA welding fittings, flanges, etc. Wells for larger pipe size fittings are available on request.

Materials:
Carbon Steel (C-1018), A.I.S.I. - 304, A.I.S.I. -316 are standard. Other materials are available on request.

Lagging Extension:
When specifying lagging extension, choose a length which will permit the use of a standard element length. (See 260L and 385L lengths)

Cap & Chain
Prices listed on Page B-19.

Series 260W



All dimensions are in inches.

*NPSM internal pipe thread will accept both NPT and NPS male threads.

Pipe Size P	Type Number	Shank Dia. Q	P	Stem Length A	Length Insert. U	Materials & Prices Stainless St. 304	Stainless St. 316	Carbon Steel	Brass
¾″ Nominal (1.050 Dia.)	¾″-260W -U 2½ ☐	¾	1.050	4	2½	$ 22.00	$ 30.00	$16.50	$16.50
	-U 4½ ☐	″	″	6	4½	26.50	36.00	20.00	20.00
	-U 7½ ☐	″	″	9	7½	39.50	53.00	31.50	31.50
	-U10½ ☐	″	″	12	10½	48.00	65.00	41.00	41.00
	-U13½ ☐	″	″	15	13½	69.00	93.00	53.00	53.00
	-U16½ ☐	″	″	18	16½	82.50	111.00	63.50	63.50
	-U22½ ☐	″	″	24	22½	106.00	143.00	74.00	74.00
1″ Nominal (1.315 Dia.)	1″-260W -U 2½ ☐	⅞	1.315	4	2½	29.00	35.50	22.00	22.00
	-U 4½ ☐	″	″	6	4½	36.50	49.00	26.50	26.50
	-U 7½ ☐	″	″	9	7½	48.00	65.00	34.50	34.50
	-U10½ ☐	″	″	12	10½	60.00	80.00	46.00	46.00
	-U13½ ☐	″	″	15	13½	83.00	111.50	61.00	61.00
	-U16½ ☐	″	″	18	16½	97.00	130.50	71.50	71.50
	-U22½ ☐	″	″	24	22½	132.50	164.00	83.00	83.00

Material - 304 S.S., Carbon Steel, etc.
Insertion length dimension
Bore size - inch
External thread - NPT

Pressure - Temperature rating — lbs. per sq. inch

Material	Temperature — °F 70°	200°	400°	600°	800°	1000°	1200°
Brass	5000	4200	1000	—	—	—	—
	5200	5000	4800	4600	3500	1500	—
A.I.S.I. - 304	7000	6200	5600	5400	5200	4500	1650
A.I.S.I. - 316	7000	7000	6400	6200	6100	5100	2500
Monel	6500	6000	5400	5300	5200	1500	—

See Page B-29 for Maximum Fluid Velocity.

To order, please specify:
1. Complete Type Number
2. Material
3. Cap & Chain — If Desired

See ordering information — Page B-20

Series 260V and 385V

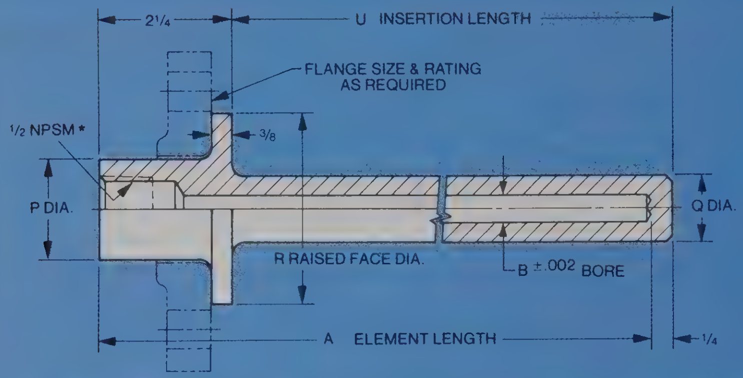
Van Stone Thermowells for 1/4″ and 3/8″ Diameter Elements

Application:
260V series fits standard length 1/4″ diameter elements. 385V series fits standard length 3/8″ diameter elements.

Connection Size:
Standard wells fit 1″ and 1 1/2″ lap joint flanges. Other sizes also available. Prices below are for 1″ flanges. Consult factory for prices on other sizes.

Materials:
Carbon Steel (C-1018), A.I.S.I. - 304, A.I.S.I. - 316 and Monel are standard. Other materials are available.

Backing Flange:
When desired, a carbon steel lap joint flange can be supplied with these wells. When ordering, specify flange pressure.



All dimensions are in inches.

*NPSM internal pipe thread will accept both NPT and NPS male threads.

Series 260V

Type Number	Elem. Lgth. **A**	Insert. Lgth. **U**	Shank Dia. **Q**	Bore Dia. **B**	Material & Prices Stainless St. 304	316
1″- 260V -U 2☐	4	2	3/4	.260	$ 84.00	$104.00
-U 4☐	6	4	"		96.00	129.00
-U 7☐	9	7	"		114.00	153.00
-U10☐	12	10	"		132.00	177.50
-U13☐	15	13	"		150.00	202.00
-U16☐	18	16	"		168.00	226.00
-U22☐	24	22	"		205.00	275.50

Material - 304 S.S., Carbon Steel, etc.
Insertion length dimension
Bore size - inch
Type size

Series 385V

Type Number	Elem. Lgth. **A**	Insert. Lgth. **U**	Shank Dia. **Q**	Bore Dia. **B**	Material & Prices Stainless St. 304	316
1″- 385V -U 2☐	4	2	7/8	.385	$ 84.00	$104.00
-U 4☐	6	4	"		96.00	129.00
-U 7☐	9	7	"		114.00	153.00
-U10☐	12	10	"		132.00	177.50
-U13☐	15	13	"		150.00	202.00
-U16☐	18	16	"		168.00	226.00
-U22☐	24	22	"		205.00	275.50

Material - 304 S.S., Carbon Steel, etc.
Insertion length dimension
Bore size - inch
Type size

Maximum Fluid Velocity — feet per second (see Section on Velocity — Page B-18)

Well Type	Material	Insertion Length — "U" 2	4	7	10	13	16	22
260V and 260F	Carbon Steel	404 (129)	184 (71.2)	67.0 (42.7)	34.0	20.6	13.7	7.4
	A.I.S.I. 304 & 316	430 (179)	192 (99.3)	69.7 (59.6)	35.4	21.5	14.3	7.7
	Monel	350 (143)	168 (79.8)	61 (47.7)	31.0	18.8	12.5	6.7
385V and 385F	Carbon Steel	410 (152)	248 (84.3)	91.3 (50.6)	45.7	27.6	18.5	10.0
	A.I.S.I. 304 & 316	444 (211)	258 (117)	95.2 (70.3)	47.6	28.8	19.3	10.4
	Monel	338 (168)	226 (93.3)	83.3 (56.0)	41.6	25.2	16.9	9.1

Other Dimensions

Pipe Size Nominal	Actual Dia. P	Raised Face Dia. R
1	1.315	2
1 1/2	1.900	2 7/8

To order, please specify:
1. Complete Type Number
2. Material
3. Flange Size
4. Backing Flange Pressure Desired

Series 260F and 385F

Flanged Thermowells for 1/4″ and 3/8″ Diameter Elements

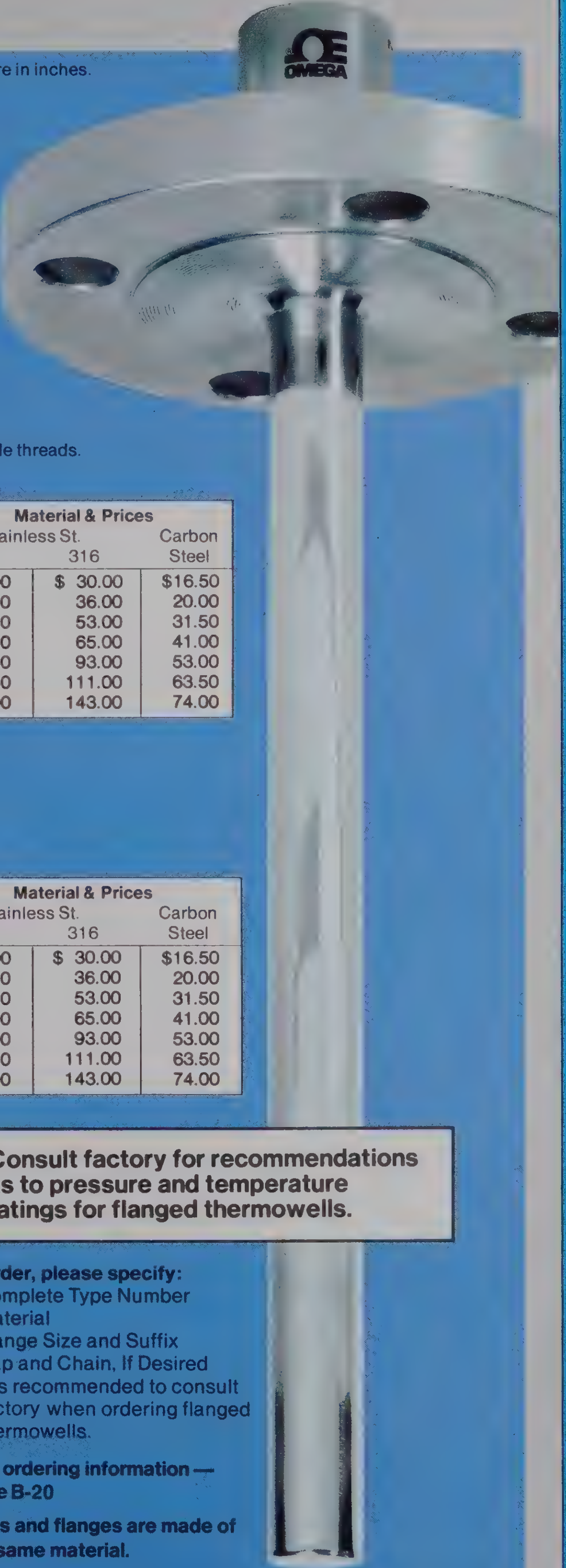
Application:
260F series fits standard length 1/4″ diameter elements.
385F series fits standard length 3/8″ diameter elements.

Flange Sizes:
1″ and 1 1/2″ flanges in all facings and pressure ratings are standard. Other sizes are available on application.

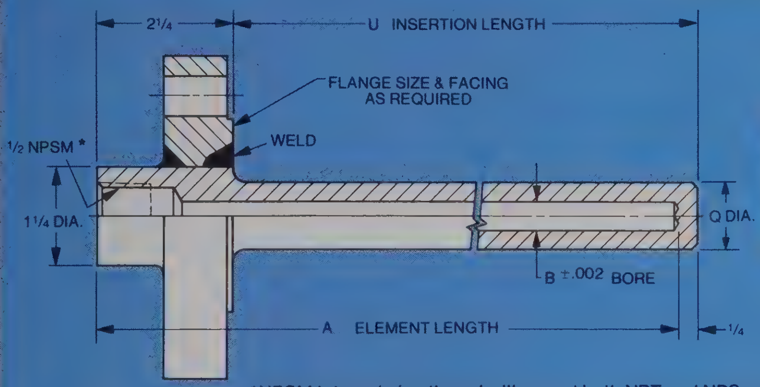
Materials:
Flanges and wells made of Carbon Steel (C-1018), A.I.S.I. - 304, A.I.S.I. - 316 and Monel are available for quick delivery. Other materials are available.

Welding:
Primary weld is "J" groove type; secondary weld is 45° bevel groove. Welding is performed by Navy certified welders using inert gas shielded arc.

Cap & Chain
Prices listed on Page B-19.



All dimensions are in inches.



*NPSM internal pipe thread will accept both NPT and NPS male threads.

Series 260F

Type Number	Elem. Lgth. **A**	Insert. Lgth. **U**	Shank Dia. **Q**	Bore Dia. **B**	Material & Prices Stainless St. 304	Stainless St. 316	Carbon Steel
260F-U 2□	4	2	3/4	.260	$ 22.00	$ 30.00	$16.50
-U 4□	6	4	″		26.50	36.00	20.00
-U 7□	9	7	″		39.50	53.00	31.50
-U10□	12	10	″		48.00	65.00	41.00
-U13□	15	13	″		69.00	93.00	53.00
-U16□	18	16	″		82.50	111.00	63.50
-U22□	24	22	″		106.00	143.00	74.00

Material - 304 S.S., Carbon Steel, etc.
Insertion length dimension
Bore size - inch

Series 385F

Type Number	Elem. Lgth. **A**	Insert. Lgth. **U**	Shank Dia. **Q**	Bore Dia. **B**	Material & Prices Stainless St. 304	Stainless St. 316	Carbon Steel
385F-U 2□	4	2	7/8	.385	$ 22.00	$ 30.00	$16.50
-U 4□	6	4	″		26.50	36.00	20.00
-U 7□	9	7	″		39.50	53.00	31.50
-U10□	12	10	″		48.00	65.00	41.00
-U13□	15	13	″		69.00	93.00	53.00
-U16□	18	16	″		82.50	111.00	63.50
-U22□	24	22	″		106.00	143.00	74.00

Material - 304 S.S., Carbon Steel, etc.
Insertion length dimension
Bore size - inch

Consult factory for recommendations as to pressure and temperature ratings for flanged thermowells.

Standard Flanges

Rating lb/in²	Size Inch	Catalog No. (Flange Suffix)	Material & Prices Stainless St. 304	Stainless St. 316	Carbon Steel
150	1″	1″-150RF(or FF) □	$ 67.50	$ 90.50	$ 52.00
	1 1/2″	1 1/2″-150RF(or FF) □	82.50	111.00	60.00
	2″	2″-150RF(or FF) □	109.00	146.50	79.00
300	1″	1″-300RF(or FF) □	110.00	147.50	82.00
	1 1/2″	1 1/2″-300RF(or FF) □	120.00	161.00	82.00
	2″	2″-300RF(or FF) □	147.00	197.50	107.50

Material, 304SS, Etc.
Raised Face, (or Flat Face Flange)
Rating
Flange Size - Inches

To order, please specify:
1. Complete Type Number
2. Material
3. Flange Size and Suffix
4. Cap and Chain, If Desired
5. It is recommended to consult factory when ordering flanged thermowells.

See ordering information — Page B-20

Wells and flanges are made of the same material.

Series 445L

Standard Threaded Well for Industrial Glass Thermometers

Application:
Fits liquid-in-glass thermometers made to S.A.M.A. standards. Tapered bore is made .008 in. oversize to eliminate possibility of thermometer bulb expanding into the well, thus preventing removal.

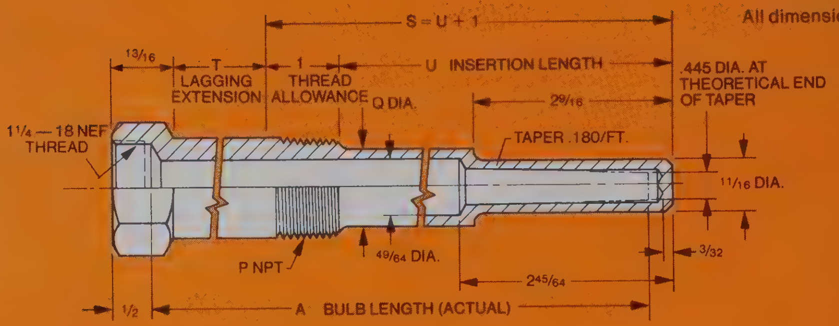
Connection Size:
3/4″ NPT and 1″ NPT are standard. Other sizes available upon request.

Materials:
Carbon Steel (C-1018), Brass (ASTM B-16), A.I.S.I. - 304, A.I.S.I. - 316, Monel. Many other materials are available upon request.

Additional Designs:
Other designs of wells to fit this class of thermometer are available. These include socket weld, heavy duty and flanged types.

Series 445L — Lagging Extension Type

All dimensions are in inches.



Ext. Th'd **P**	**Type Number**	Nom. Bulb Lgth.	Lag. Ext. **T**	Bulb Lgth. **A**	Insert. Lgth. **U**	Shank Dia. **Q**	**Material & Prices** Stainless St. 304	316	Carbon Steel	Brass
3/4″ NPT	3/4″-**445L** -S 6E☐	6	2 1/2	6 1/8	2 9/16	—	$ 44.00	$ 58.50	$27.50	$27.50
	-S 9E☐	9	3	9 1/8	5 1/16	7/8	67.00	90.00	42.50	42.50
	-S12E☐	12	3	12 1/8	8 1/16	″	91.00	122.00	52.00	52.00
	-S18E☐	18	3	18 1/8	14 1/16	″	110.00	148.00	69.00	69.00
	-S24E☐	24	3	24 1/8	20 1/16	″	142.50	186.00	83.00	83.00
1″ NPT	1″-**445L** -S 6E☐	6	2 1/2	6 1/8	2 9/16	—	44.00	58.50	27.50	27.50
	-S 9E☐	9	3	9 1/8	5 1/16	1	67.00	90.00	42.50	42.50
	-S12E☐	12	3	12 1/8	8 1/16	″	91.00	122.00	52.00	52.00
	-S18E☐	18	3	18 1/8	14 1/16	″	110.00	148.00	69.00	69.00
	-S24E☐	24	3	24 1/8	20 1/16	″	142.50	186.00	83.00	83.00

Material - 304 S.S., Carbon Steel, etc.
Insertion length dimension
Bore size - inch
External thread - NPT

Maximum Fluid Velocity-feet per second (see Section on Velocity—Page B-18)

Well Type	**Material**	**Insertion Length — "U"** 2 9/16	5 1/16	8 1/16	11 1/16	14 1/16	17 1/16	20 1/16	23 1/16
3/4″-445S and 3/4″-445L	Brass	259 (52.3)	142 (26.4)	55.8 (16.6)	29.8 (12.1)	18.4 (9.5)	12.5 (7.8)	9.0 (6.7)	6.8
	Carbon Steel	352 (94.6)	198 (48.0)	77.5 (30.1)	41.4 (22.0)	27.8 (17.3)	17.3 (14.2)	12.5 (12.1)	9.5
	A.I.S.I. 304 & 316	382 (131)	206 (66.3)	80.9 (41.7)	43.2 (30.2)	26.6 (24.0)	18.1	13.1	9.9
	Monel	277 (105)	179 (53.1)	70.3 (33.4)	37.5 (24.3)	23.2 (19.1)	15.7	11.3	8.5
1″-445S and 1″-445L	Brass	259 (76)	156 (38.5)	61.4 (24.2)	32.8 (17.7)	20.2 (13.9)	13.7 (11.4)	9.9	7.5
	Carbon Steel	352 (137)	215 (69.4)	34.2 (43.6)	45.0 (31.9)	27.7 (25)	18.9	13.6	10.3
	A.I.S.I. 304 & 316	382 (190)	224 (96.1)	87.8 (60.4)	46.9 (44.1)	28.9	19.7	14.2	10.8
	Monel	277 (152)	196 (77.1)	77.2 (48.5)	41.4 (35.4)	25.4	17.2	12.4	9.4

See Page B-34 for Pressure-Temperature Ratings.

To order, please specify:
1. Complete Type Number
2. Material

See ordering information—Page B-20

Series 445S

Standard Threaded Well for Industrial Glass Thermometers

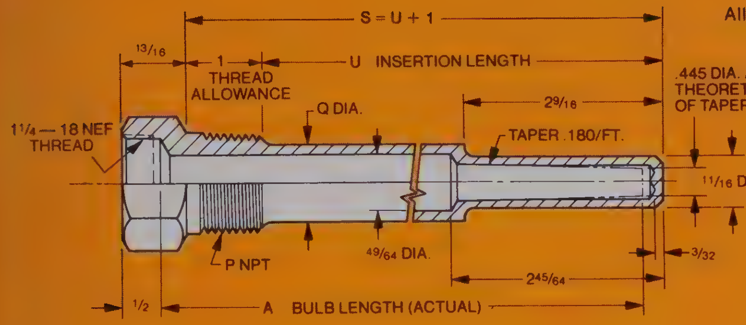
Application:
Fits liquid-in-glass thermometers made to S.A.M.A. standards. Tapered bore is made .008 in. oversize to eliminate possibility of thermometer bulb expanding into the well, thus preventing removal.

Connection Size:
3/4″ NPT and 1″ NPT are standard. Other sizes available upon request.

Materials:
Carbon Steel (C-1018), Brass (ASTM B-16), A.I.S.I. - 304, A.I.S.I. - 316, Monel. Many other materials are available upon request.

Additional Designs:
Other designs of wells to fit this class of thermometer are available. These include socket weld, heavy duty and flanged types.

Series 445S — General Use



All dimensions are in inches.

Ext. Th'd **P**	**Type Number**	Nominal Bulb Lgth.	Bulb Lgth. **A**	Insert. Lgth. **U**	Shank Dia. **Q**	Material & Prices Stainless St. 304	Material & Prices Stainless St. 316	Carbon Steel	Brass
3/4″ NPT	**3/4″-445S** -S3 1/2☐	3 1/2	3 5/8	2 9/16	—	$ 29.00	$ 39.00	$18.50	$18.50
	-S6☐	6	6 1/8	5 1/16	7/8	44.00	58.50	27.50	27.50
	-S9☐	9	9 1/8	8 1/16	″	67.00	90.00	42.50	42.50
	-S12☐	12	12 1/8	11 1/16	″	91.00	122.00	52.00	52.00
	-S18☐	18	18 1/8	17 1/16	″	110.00	148.00	69.00	69.00
	-S24☐	24	24 1/8	23 1/16	″	142.50	186.00	83.00	83.00
1″ NPT	**1″-445S** -S3 1/2☐	3 1/2	3 5/8	2 9/16	—	29.00	39.00	18.50	18.50
	-S6☐	6	6 1/8	5 1/16	1	44.00	58.50	27.50	27.50
	-S9☐	9	9 1/8	8 1/16	″	67.00	90.00	42.50	42.50
	-S12☐	12	12 1/8	11 1/16	″	91.00	122.00	52.00	52.00
	-S18☐	18	18 1/8	17 1/16	″	110.00	148.00	69.00	69.00
	-S24☐	24	24 1/8	23 1/16	″	142.50	186.00	83.00	83.00

Material - 304 S.S., Carbon Steel, etc.
Insertion length dimension
Bore size - inch
External thread - NPT

Pressure — Temperature rating — lbs. per sq. inch

Well Type	Material	Temperature — °F. 70°	200°	400°	600°	800°	1000°
3/4″-445S and 3/4″-445L (See Note)	Brass	640	575	100	—	—	—
	Carbon Steel	720	690	660	630	480	210
	A.I.S.I. 304	940	850	770	740	720	625
	A.I.S.I. 316	940	940	875	850	840	700
	Monel	900	825	740	730	710	210
1″-445S and 1″-445L (See Note)	Brass	1470	1320	230	—	—	—
		1650	1590	1520	1450	1100	480
	A.I.S.I. 304	2150	1950	1770	1710	1670	1430
	A.I.S.I. 316	2150	2150	2010	1960	1920	1610
	Monel	2070	1900	1700	1690	1640	480

Note: Wells with 2 9/16 insertion length have three times the pressure ratings shown.

See Page B-33 for Maximum Fluid Velocity.

To order, please specify:
1. Complete Type Number
2. Material

See ordering information—Page B-20

Series 385A

General Purpose Test Well for 3/8″ Diameter Elements

Application:
Armored liquid-in-glass test thermometers. #14 gage test thermocouples. Bimetal test thermometers.

Connection Size:
1/2″ NPT external thread is standard.

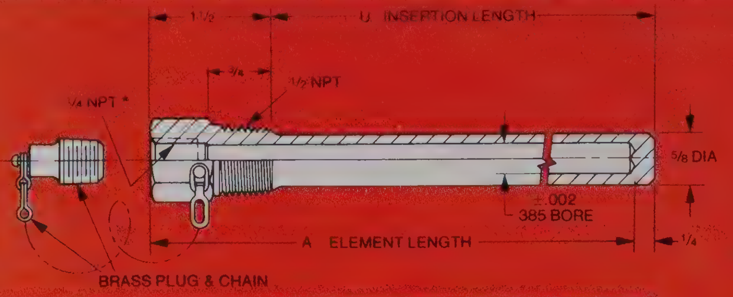
Lagging Extension:
When extra head length is required to extend through insulation, 2 1/2″ lagging extension is standard.

Materials:

Brass (A.S.T.M. B-16)	Carbon Steel (C-1018)
A.I.S.I. 304	A.I.S.I. 316

Other materials are available on request.

Cap & Chain
Captive plug & Chain is furnished on all wells as standard.



All dimensions are in inches.

*NPSM internal pipe thread will accept both NPT and NPS male threads.

Type Number	Insertion Length U	Element Length A	Material & Prices Stainless St. 304	Stainless St. 316	Carbon Steel	Brass
1/2″-**385A**-U 2☐	2	3 1/4	$23.00	$31.00	$19.50	$19.50
-U 4☐	4	5 1/4	28.00	37.50	22.00	22.00
-U 6☐	6	7 1/4	33.00	44.50	25.50	25.50
-U 8☐	8	9 1/4	38.50	51.50	29.00	29.00
-U10☐	10	11 1/4	43.50	58.50	32.00	32.00
-U12☐	12	13 1/4	48.50	65.50	35.00	35.00

Material - 304 S.S., Carbon Steel, etc.
Insertion length dimension
Bore size - inch
External thread - NPT

Velocity Rating – feet per second

Material	Insertion Length — "U" 2	4	6	8	10	12
Brass	362 (74)	115 (37)	51.4 (24.7)	28.9 (18.5)	18.5 (14.8)	12.8 (12.3)
Carbon Steel	422 (156)	155 (78)	69.1 (52.1)	38.9	24.9	17.3
A.I.S.I. 304 & 316	450 (223)	162 (112)	72.2	40.6	26.0	18.1
Monel	382 (147)	145 (73.8)	64.7 (49.2)	36.4	23.3	16.1

Pressure - Temperature Rating —lbs. per sq. inch

Material	Temperature — °F 70°	200°	400°	600°	800°	1000°	1200°
Brass	2810	2530	440	—	—	—	—
Carbon Steel	3160	3040	2900	2770	2110	920	—
A.I.S.I. - 304	4120	3740	3400	3280	3180	2750	990
A.I.S.I. - 316	4120	4120	3850	3760	3680	3080	1490

To order, please specify:

1. Complete Type Number
2. Material
3. Cap & Chain, If Desired (Standard on 385A)

See ordering information—Page B-20

Series 260A

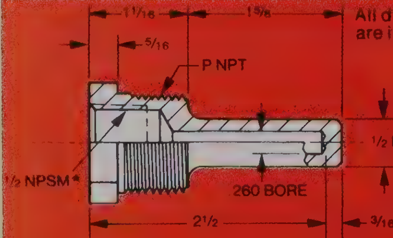
Limited Space Thermowell for 1/4″ Diameter Elements

Application:
Used where short insertion length is necessary as in short legs of tees, etc. This well also fits the 2½″ length bimetal thermometer with ¼″ stem diameter.

Connection Size:
3/4″ NPT and 1″ NPT external thread.

Standard Materials:
Brass (A.S.T.M. B-16); Carbon Steel (C-1020) A.I.S.I. 304; A.I.S.I. - 316, Monel.

Cap and Chain:
Prices listed on Page B-19



All dimensions are in inches.

*NPSM internal pipe thread will accept both NPT and NPS male threads.

Most Popular Size ▶

External Thread P	Type Number	Material & Prices Stainless St. 304	Stainless St. 316	Carbon Steel	Brass
3/4″ NPT	3/4″ - **260A**-U1 5/8″ ☐	$20.00	$27.00	$14.00	$14.00
1″ NPT	1″-**260A**-U1 5/8″ ☐	22.50	30.50	17.50	17.50

Material - 304 S.S., Carbon Steel, etc
Insertion length dimension
Bore size - inch
External thread - NPT

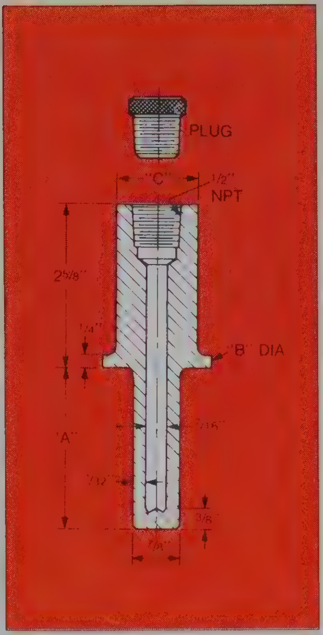
Pressure - Temperature Rating:
Use Values Given For Series 260S Wells

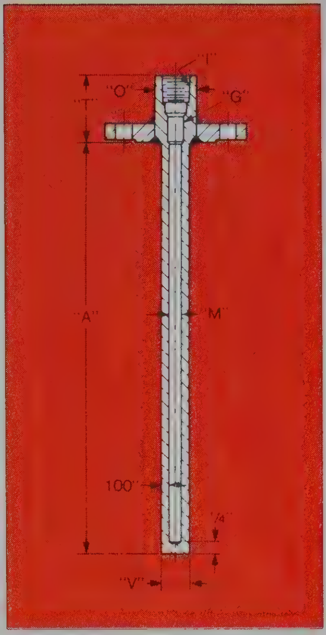
Velocity Rating:
Use Values Given For Series 260S Wells in 2 1/2″ insertion length column.

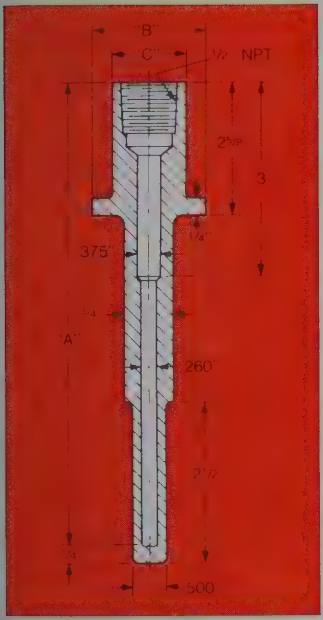
To order, please specify:

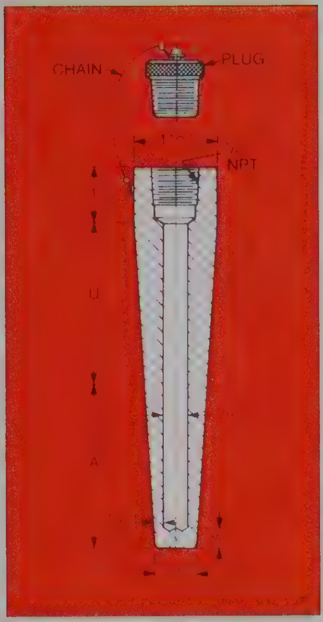
1. Complete Type Number
2. Material
3. Cap & Chain, If Desired (Standard on 385A)

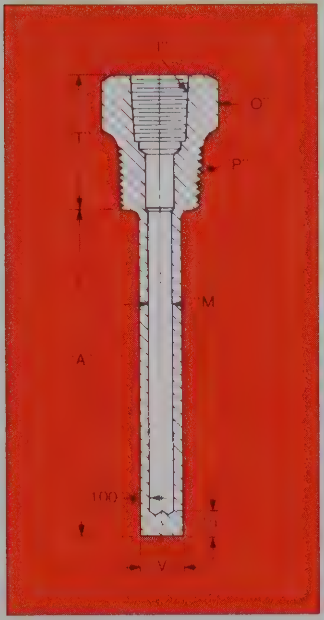
Just a few of OMEGA'S Special and Custom Well Styles that are too numerous to list. If you need a special well, consult OMEGA®.


PLUG
"C"
1/2" NPT
2⅝"
¼"
"B" DIA
"A"
7/32"
3/8
7/8"


"I"
"O"
"G"
"T"
"A"
"M"
100"
¼"
"V"


"B"
"C"
½ NPT
2⅝
3
¼"
375"
"A"
260"
2½
500


CHAIN
PLUG
NPT
U
A


I
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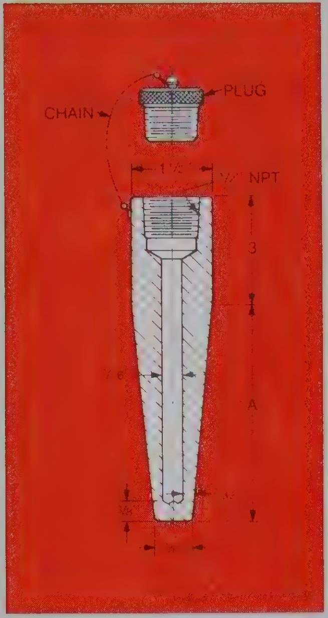
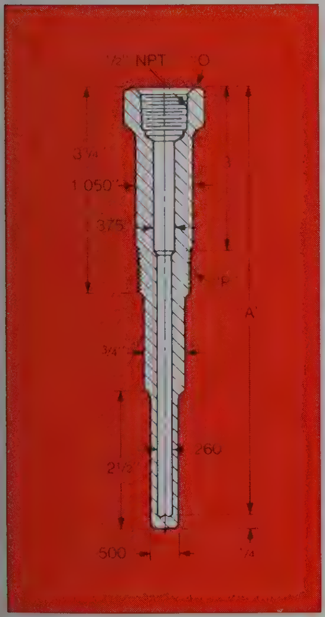
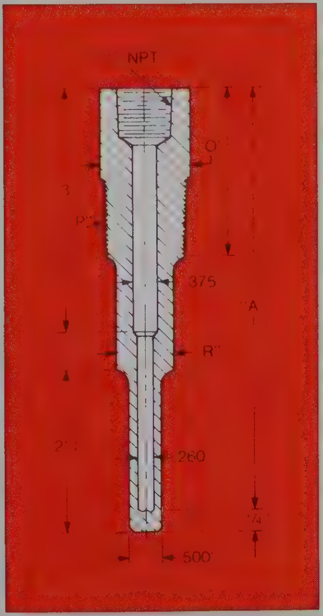
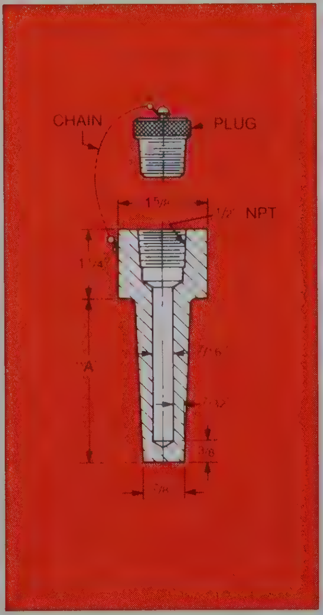
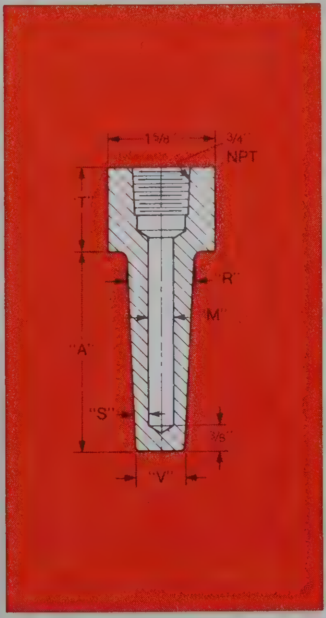

PLUG
CHAIN
NPT
3
A


½" NPT
O
3¼"
1.050"
375"
P
A
¾"
260
2½
500
¼


NPT
O
P
375
A
R
260
¼
500


CHAIN
PLUG
1⅝
½ NPT
1¼"
A
3/8

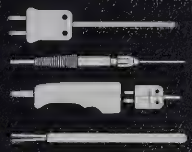
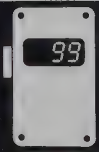

1⅝
¾"
NPT
"T"
R
"M"
"A"
"S"
3/8
"V"

OMEGA 868 THERMOMETER
86.8
HOLD
200
OFF
100 Ω PLATINUM RTD
α = 0.00385
RANGE -360°F to 1100°F
42V MAX
BAT. LOW
70.0
+32°F to +199°F
OFF
-22°F to +122°F
MODEL 700F
THERMISTOR THERMOMETER
RANGE -22.0°F to +199.9°F
OMEGA ENGINEERING
Stamford, CT U.S.A.
450 °C
OMEGA 450 AET
THERMOCOUPLE THERMOMETER
TYPE E
HOLD
ON °F
1°
0.1°
OFF
ON °C
TEMPERATURE INDICATOR
OMEGA

OMEGASCOPE™
OMEGA ENGINEERING INC.
Stamford, Connecticut, U.S.A.
TMP
AVG
MAX
MIN
DIF
183.8
°F
°C
ε
NO YES
DISPLAY SELECT
USE STORED DATA?
SCALE SELECT
EMISSIVITY
OMEGASCOPE
OMEGA ENGINEERING INC.
OMEGA 871 DIGITAL THERMOMETER
1492
2000
200
TC1
TC 500V MAX
TC2
mV OUT
NiCr-NiAl

C Infrared and Hand Held Instruments

For Temperature, Millivolts and Milliamps

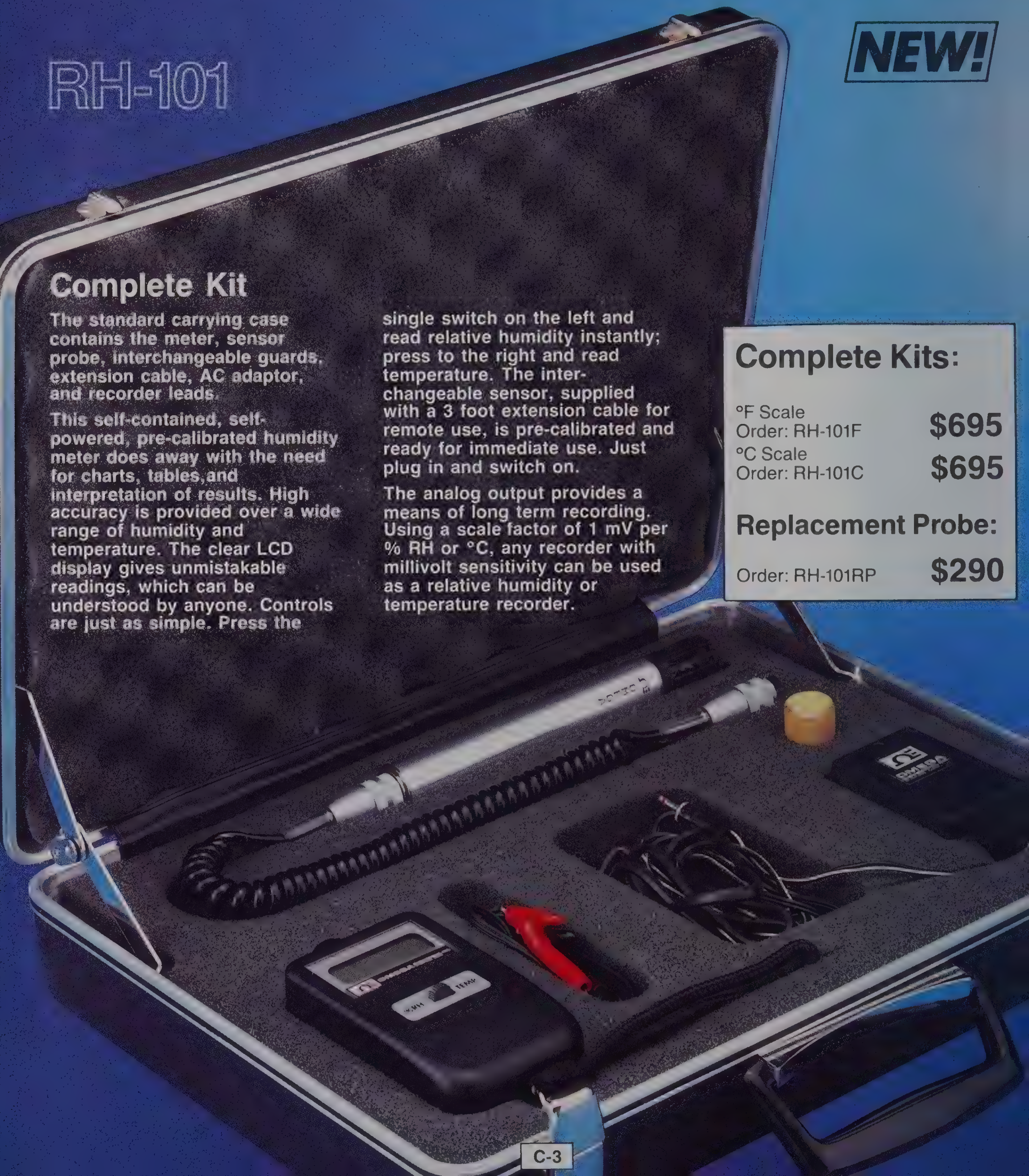
Hand Held Relative Humidity and Temperature Meters **NEW**		C-3
Probe Selector Guide for Hand Held Meters		C-6
800 Series Thermocouple, Thermistor and Multimeter Models **NEW**		C-7
Model TTC/TTF Temperature Transducer **NEW**		C-15
450 Series Thermometers, Thermocouple, Thermistor and RTD Models		C-16
HH-99 Series Low Cost Digital Thermocouple Thermometer **NEW**		C-21
700 Series Thermocouple, Thermistor and RTD Thermometers		C-22
OMEGASCOPE™ Hand Held Pyrometers Series 500, 600, 760 **NEW**		C-26
OMEGASCOPE™ 2000/3000 Precision Computerized Infrared Pyrometers		C-32
OMEGASCOPE™ II Industrial Infrared Pyrometer **NEW**		C-38
Portable Analog Thermometer		C-44

Hand Held Hygrometers

HUMIDITY AND TEMPERATURE

NEW!

RH-101



Complete Kit

The standard carrying case contains the meter, sensor probe, interchangeable guards, extension cable, AC adaptor, and recorder leads.

This self-contained, self-powered, pre-calibrated humidity meter does away with the need for charts, tables, and interpretation of results. High accuracy is provided over a wide range of humidity and temperature. The clear LCD display gives unmistakable readings, which can be understood by anyone. Controls are just as simple. Press the single switch on the left and read relative humidity instantly; press to the right and read temperature. The interchangeable sensor, supplied with a 3 foot extension cable for remote use, is pre-calibrated and ready for immediate use. Just plug in and switch on.

The analog output provides a means of long term recording. Using a scale factor of 1 mV per % RH or °C, any recorder with millivolt sensitivity can be used as a relative humidity or temperature recorder.

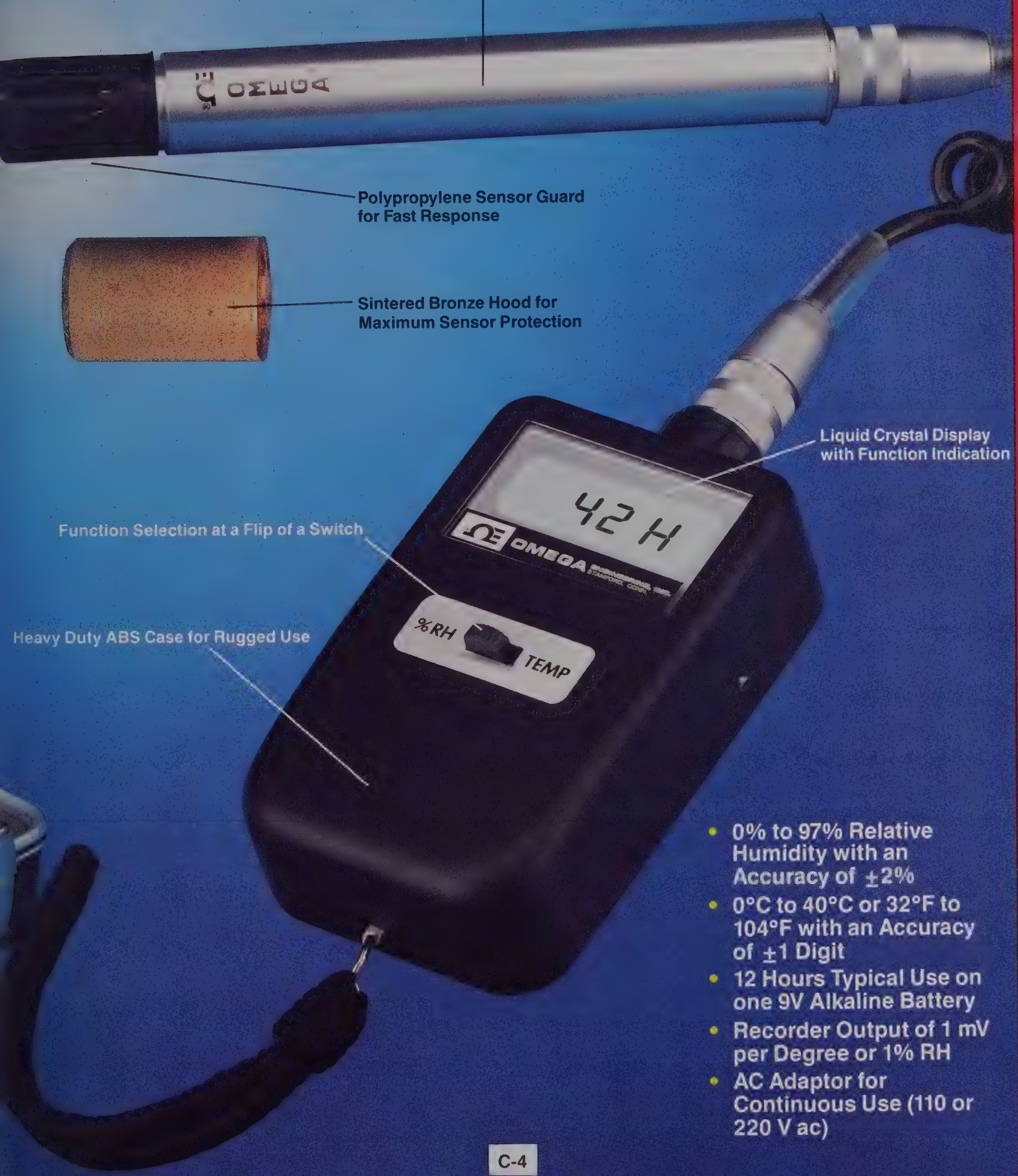
Complete Kits:

°F Scale Order: RH-101F	**$695**
°C Scale Order: RH-101C	**$695**

Replacement Probe:

Order: RH-101RP	**$290**

FROM ONE INSTRUMENT


Sensors and Conditioning Electronics in a Rugged Anodized Aluminum Body
Polypropylene Sensor Guard for Fast Response
Sintered Bronze Hood for Maximum Sensor Protection
Liquid Crystal Display with Function Indication
Function Selection at a Flip of a Switch
Heavy Duty ABS Case for Rugged Use
OMEGA
42 H
%RH
TEMP

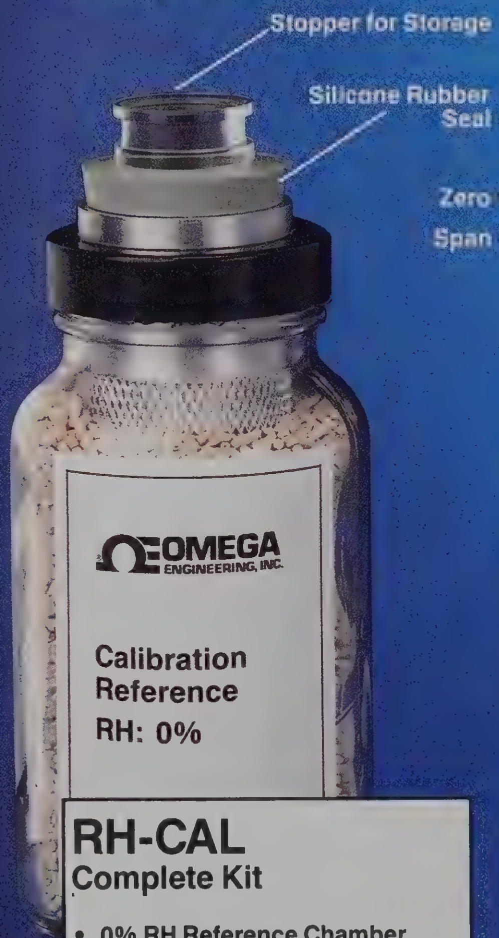
- 0% to 97% Relative Humidity with an Accuracy of ±2%
- 0°C to 40°C or 32°F to 104°F with an Accuracy of ±1 Digit
- 12 Hours Typical Use on one 9V Alkaline Battery
- Recorder Output of 1 mV per Degree or 1% RH
- AC Adaptor for Continuous Use (110 or 220 V ac)

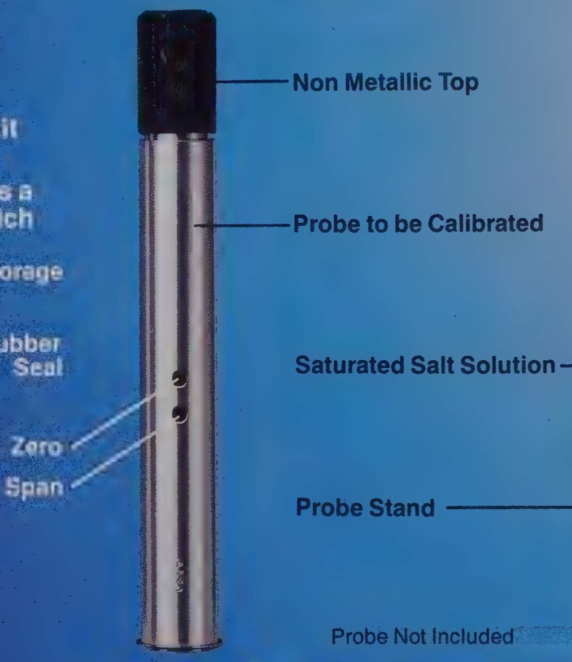
Hand Held Hygrometer
REFERENCE STANDARDS

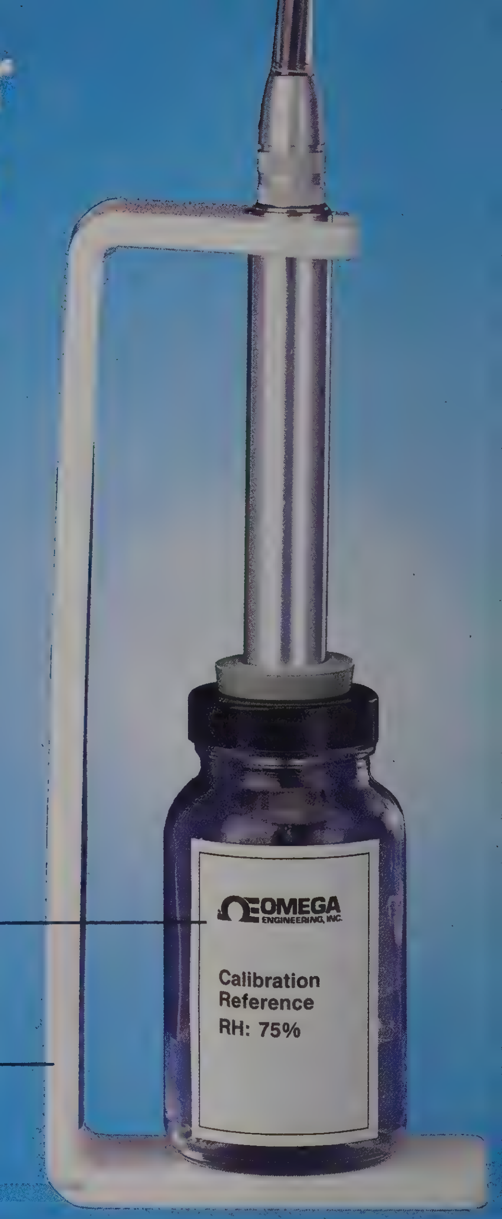
Use the 0% RH and 75% RH Reference Assemblies to set the zero and span on the RH101 Humidity and Temperature Probe.

When a closed air space is maintained in equilibrium with a saturated aqueous salt solution, the relative humidity of the enclosed air remains constant as long as the temperature and pressure do not change. The level of humidity established depends on the type of salt used. High purity sodium chloride is supplied with the kit which yields 75% RH at 25°C.

The 0% RH Assembly contains a molecular sieve dessicant which absorbs any moisture present in the container. The enclosed air space will therefore remain dry within 0.5% RH for a very long period. As long as the seals are in good condition and the container remains closed when not in use, up to 500 calibration check operations can be satisfactorily carried out.


Stopper for Storage
Silicone Rubber Seal
OMEGA ENGINEERING, INC.
Calibration Reference
RH: 0%


Non Metallic Top
Probe to be Calibrated
Saturated Salt Solution
Zero
Span
Probe Stand


OMEGA ENGINEERING, INC.
Calibration Reference
RH: 75%

Probe Not Included

RH-CAL
Complete Kit

- 0% RH Reference Chamber
- 75% RH Reference
  (High Purity Sodium Chloride)
- Solution Reference Chamber
- Calibration Stand
- Calibration Thermometer

ORDER: RH-CAL $129

Relative Humidity % Over Saturated Salt Solutions

Temperature	Lithium Chloride Monohydrate	Magnesium Chloride Hexahydrate	Sodium Dichromate Dihydrate	Sodium Chloride	Potassium Chromate	Ammonium Dihydrogen Phosphate	Potassium Sulphate
15°C (59°F)	—	34%	56%	76%	—	—	97%
20°C (68°F)	11%	34%	55%	76%	87%	93%	97%
25°C (77°F)	11%	33%	54%	75%	86%	93%	97%
30°C (86°F)	11%	33%	52%	75%	86%	92%	97%
35°C (95°F)	11%	33%	51%	75%	86%	92%	96%

NOTE: Where no Relative Humidity figure is tabled, then the temperature is considered below the normal usable range for that particular salt solution.
Only Sodium Chloride is supplied by OMEGA.

W EDITION!

PRODUCT PREVIEW!

The Latest OMEGA® Products for Sensing and Control

OMEGA®

TEMPERATURE DEVELOPMENTS

SENSING and CONTROL

NEW! FREE!

OMEGA®

TEMPERATURE DEVELOPMENTS

An update of all the new products and technical advances for Sensing and Control

® OMEGA ENGINEERING, INC.

(203) 359-1660

RESISTANCE THERMOMETER
MODEL 661
660 °C
250

UPDATE your Temperature Measurement and Control File! Use Reply Cards on inserts throughout the Handbook to add your name to our mailing list to receive the latest Temperature Developments as they are published. If all reply cards are used, call (203) 359-1660.

PREVIEWING TOMORROW'S PRODUCTS TODAY

Low Cost 40 Channel Data Logger Model OM-202-40

Precision Hand Held Thermometer Model HH-80K

Corrosion Resistant FEP Coated Probes

Temperature and Humidity Meter Model HT-100 $995

Self Tuning Controllers Model 6000-AT

RTD Panel Meter Model 651/661

Strain Gage/Pressure Monitor Model 199J

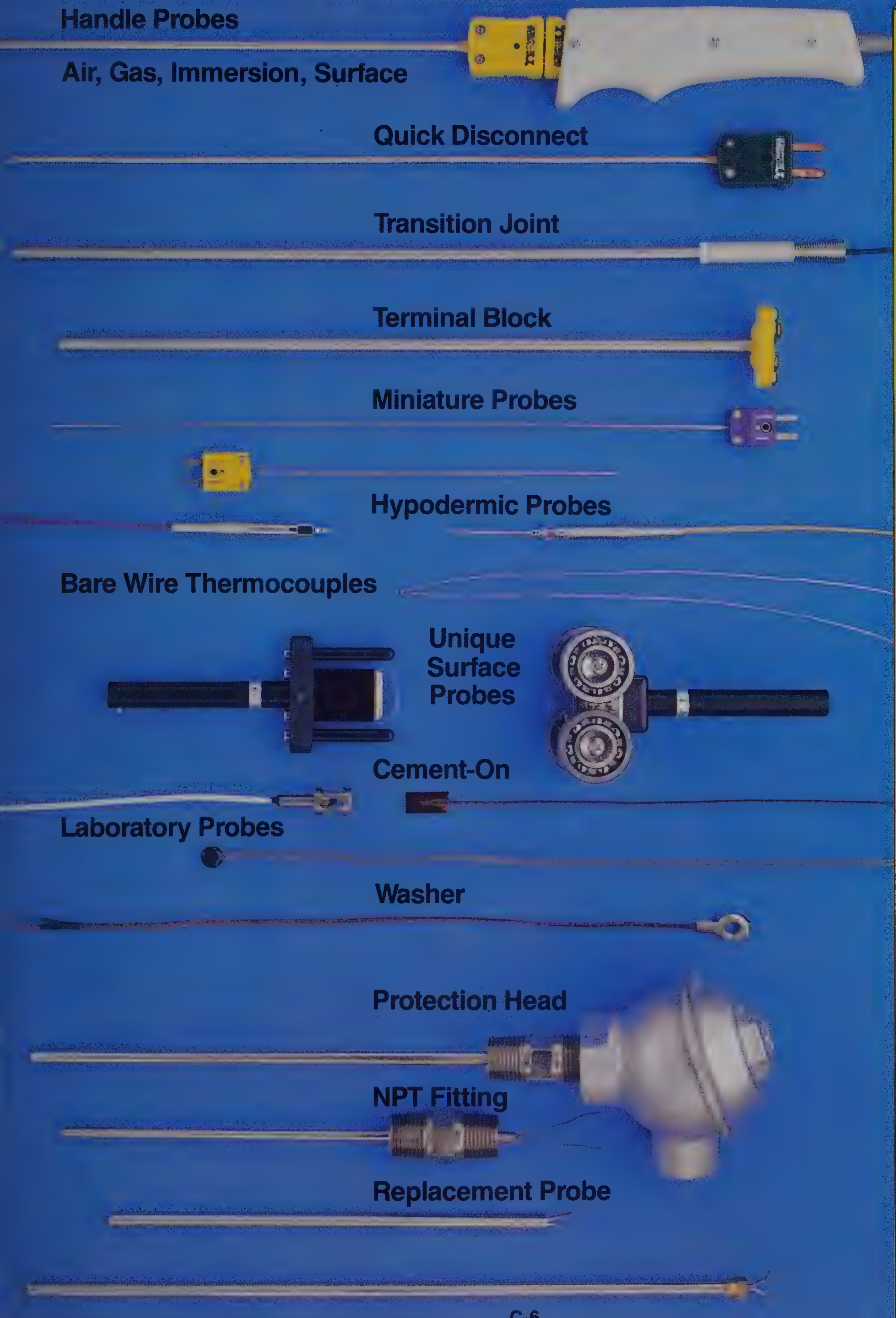
ement and Control File! Use Reply
ut the Handbook to add your name t
the latest Temperature Development
l reply cards are used,

359-1660

32.0
HH-80 K
OMEGA
40 CHANNEL MULTIPLEXER
HT 100
PROCESS
600
SET POINT
STATUS
INDEX
OMEGA ENGINEERING INC.
RESISTANCE THERMOMETER
660 °C
MODEL 66
STRAIN GAGE MONITOR

Probe Selection Guide

See Handbook Section Referenced



Handbook Section	THERMOCOUPLE	RTD	THERMISTOR
Handle Probes			
Air, Gas, Immersion, Surface	A/D	E	F
Quick Disconnect	A/D	E	F
Transition Joint	A	E	F
Terminal Block	A	E	
Miniature Probes	A	E	
Hypodermic Probes	A	E	
Bare Wire Thermocouples	A		
Unique Surface Probes	D		
Cement-On	A		
Laboratory Probes			F
Washer	A		
Protection Head	B	E	
NPT Fitting	B		
Replacement Probe	A/D	E	F

PREVIEWING TOMORROW'S PRODUCTS TODAY

RESISTANCE THERMOMETER
660
OMEGA
OM-150
320
CL-477
477C.
STRAIN GAGE MONITOR

Microprocessor Based Recorder
RD-4500 Series $835

X-Y Flatbed
Recorder
RD-200
$1500

Self Tuning Controllers
Model 6000-AT

Nisil-Nicrosil
Thermocouples

Thermocouple Interface for Apple
and IBM PC's
Model WB-TCK $585

Advanced Data Logger with Display
Model OM-272

Self Sealing Plugs for
Test Probes

Low Cost Thermocouple to
Analog Converter

New MUX Boards for
Model OM-205 Data Logger

RTD Panel Meter
Model 651/661

Strain Gage/Pressure Monitor
Model 199J

Hand Held Data Logger
Model OM-150

Low Cost Intelligent Computer Interface
Model μMEGA-4015 $720

Solid State Temperature Sensors
Series AD 590

Hand Held Calibrator
Model CL-477 $750

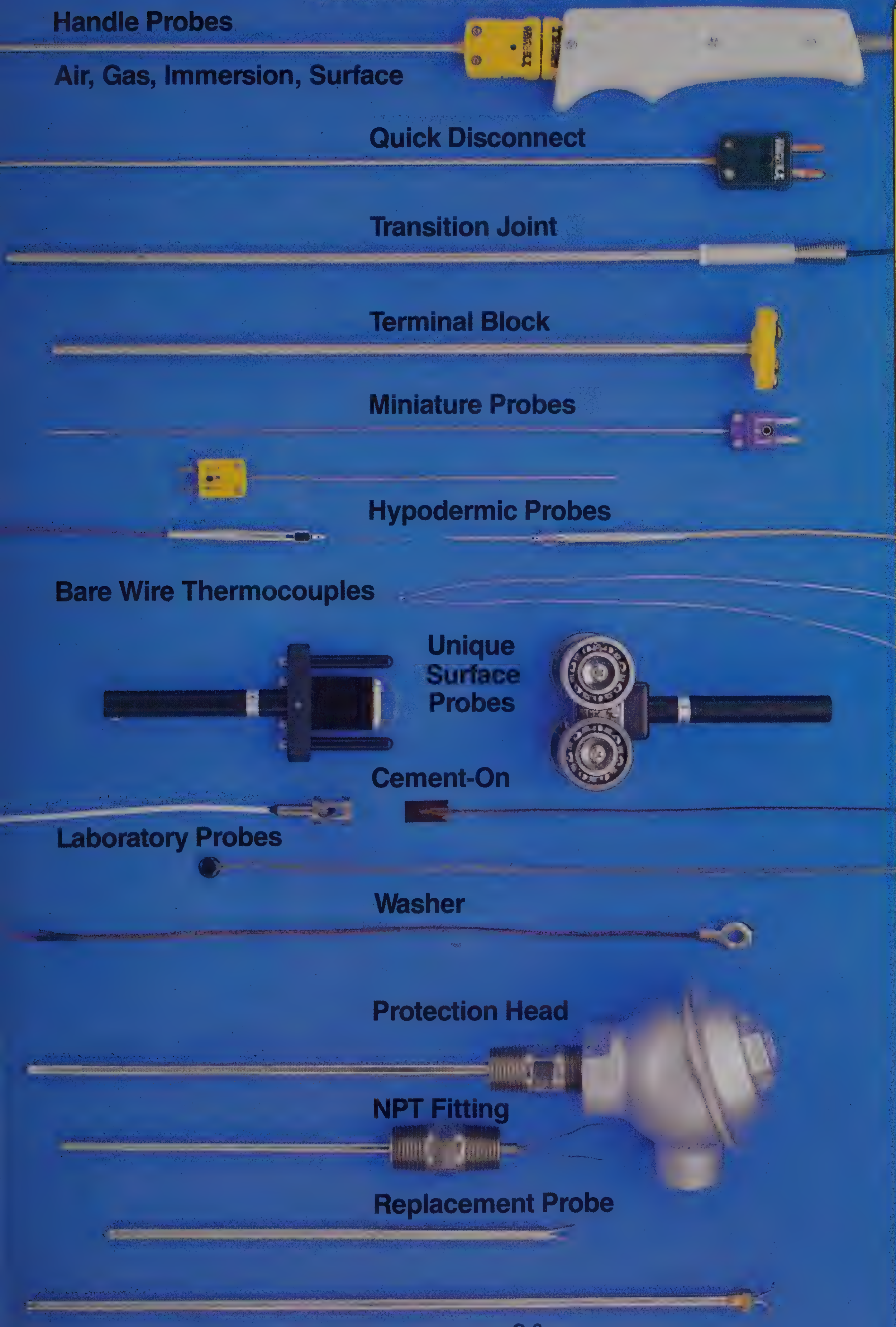
Software
for Temperature
Measurement

UPDATE your Temperature Measurement and Control File! Use Reply
Cards on inserts throughout the Handbook to add your name
our mailing list to receive the latest Temperature Developm
as they are published. If all reply cards are used,

CALL (203) 359-1660

Probe Selection Guide

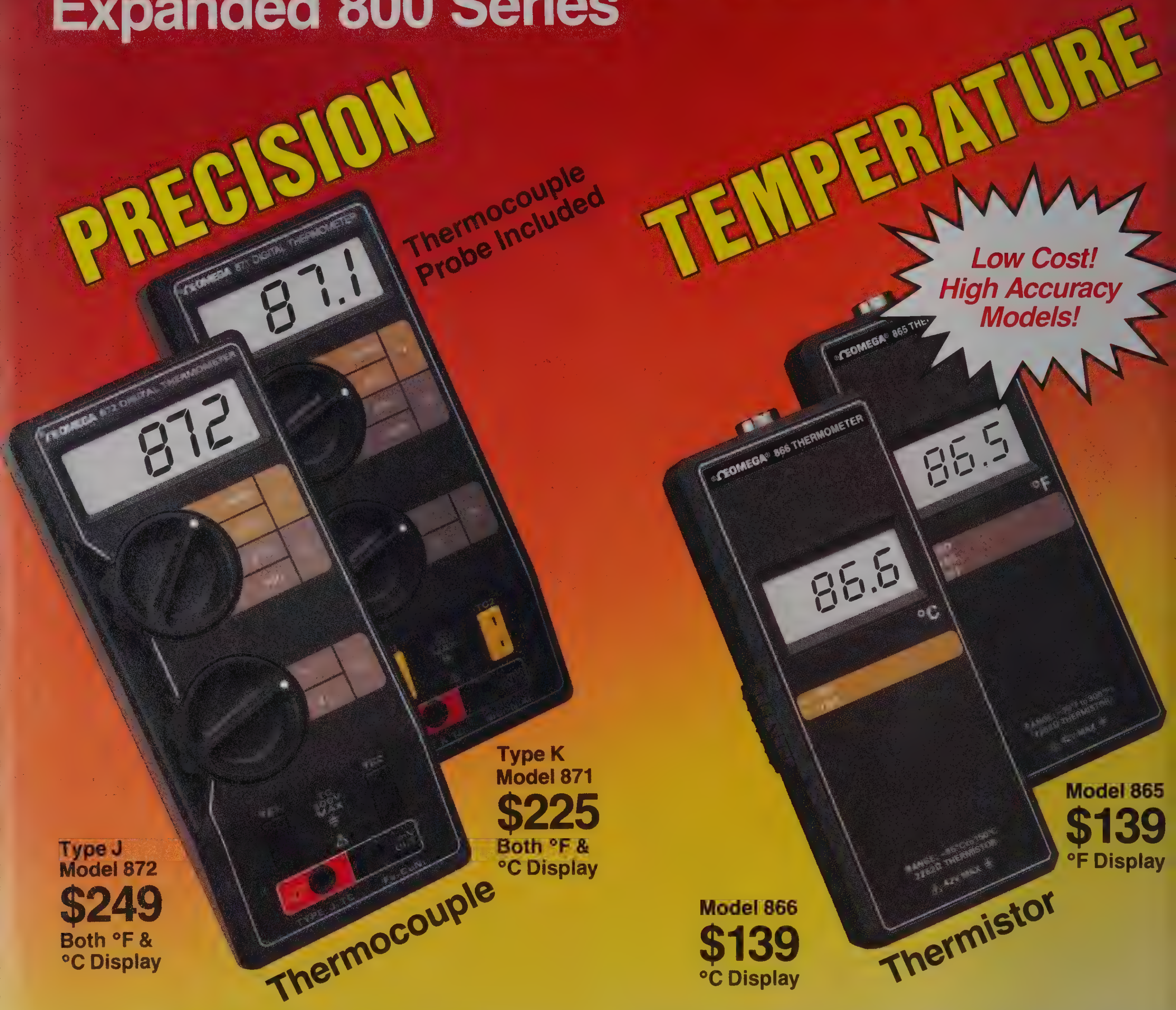
See Handbook Section Referenced



	THERMOCOUPLE	RTD	THERMISTOR
	Handbook Section		
Handle Probes **Air, Gas, Immersion, Surface**	A/D	E	F
Quick Disconnect	A/D	E	F
Transition Joint	A	E	F
Terminal Block	A	E	
Miniature Probes	A	E	
Hypodermic Probes	A	E	
Bare Wire Thermocouples	A		
Unique Surface Probes	D		
Cement-On	A		
Laboratory Probes			F
Washer	A		
Protection Head	B	E	
NPT Fitting	B		
Replacement Probe	A/D	E	F

Hand Held Thermometers NEW!

Expanded 800 Series



Thermocouple Probe Included

Type J
Model 872
$249
Both °F & °C Display

Type K
Model 871
$225
Both °F & °C Display

Model 866
$139
°C Display

Model 865
$139
°F Display

The OMEGA 871 and 872 Digital Thermocouple Thermometers offer state-of-the-art construction, high (0.25%) accuracy, and dual thermocouple inputs. They also feature selectable scales (°C/°F), 0.1° resolution up to 200°, and an ice point referenced analog output, all at an economical low price. Model 871 is for use with type K thermocouple probes, and Model 872 is for use with type J probes.

Model	Type	Setting	Range	Res.	Accuracy
871	K (Chromel/ Alumel)	200°F	−40.0 to +199.9°F	0.1°F	±(0.25% rdg +1.8°F)
		2000°F	−40 to +1999°F	1°F	
		200°C	−40.0 to +199.9°C	0.1°C	±(0.25% rdg +1°C)
		1370°C	−40 to +1370°C	1°C	
872	J (Iron/ Constantan)	200°F	−40.0 to +199.9°F	0.1°F	±(0.25% rdg +1.8°F)
		1400°F	−40 to +1400°F	1°F	
		200°C	−40.0 to +199.9°C	0.1°C	±(0.25% rdg +1°C)
		760°C	−40 to + 760°C	1°C	

OMEGA introduces two new quality thermistor thermometers featuring high accuracy at a breakthrough low price! The Model 865 and 866 meters feature high resolution, accuracy and stability for use with OMEGA Series 400 Thermistor Probes (2552 Ω @ 25°C). The rugged, double wall case construction provides environmental protection, which allows the 865 and 866 to be used in ambient temperatures as low as −10°C, and as high as 50°C, with as much as 80% relative humidity. Both units feature 0.1° resolution, and the Model 865 also features an expanded scale with 1°F resolution. Probes are easy to connect, as both models accept a standard 1/4″ phone jack (one supplied). Model 865 features °F display, and Model 866 features °C display.

Model	Setting	Range	Resolution	Accuracy
865	200°F	−70.0 to −40.1°F	0.1°F	±(0.3% rdg + 1.0°F)
		−40.0 to +199.9°F	0.1°F	±(0.3% rdg + 0.5°F)
	300°F	−70.0 to +300°F	1°F	±(0.3% rdg + 1°F)
866	150°C	−55.0 to −40.1°C	0.1°C	±(0.3% rdg + 0.6°C)
		−40.0 to +150.0°C	0.1°C	±(0.3% rdg + 0.3°C)

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(203) 359-1660

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Action Order No. ________

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ENGINEERING, INC.
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Telex 996404 Cable OMEGA FAX (203) 359-7700

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✓ TEMPERATURE
✓ PRESSURE
✓ COMPUTER INTERFACES

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PRESSURE AND STRAIN MEASUREMENT HANDBOOK
OMEGA
TEMPERATURE MEASUREMENT HANDBOOK AND ENCYCLOPEDIA
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applications engineer is ____________________

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MEASUREMENT

High Accuracy!
3 or 4
Wire Inputs!

OMEGA 869 THERMOMETER
86.9
°C
OMEGA 868 THERM
868
°F
RTD

Model 868
$249
°F Display

Model 869
$249
°C Display

The OMEGA Models 868 and 869 are the first hand held thermometers for use with either 3 or 4 wire platinum RTD's. These units feature the quality construction of the other Series 800 units, and the precision electronics to maximize the inherent high accuracy of platinum RTD's. Connections to these instruments are easy, using the OMEGA Series T four pin connectors (One Model TA4F connector is supplied with each instrument). Both the Model 868 and 869 offer 0.1° resolution between −199.9 and +199.9°, and 1° resolution to 1100°F or 630°C, and are switchable to accept either 3 or 4 wire RTD configurations. These units can be used with any standard 100 Ω platinum RTD (α = 0.00385). Model 868 reads in °F, Model 869 reads in °C.

Model	Setting	Range	Res.	Accuracy
868	200°F	−199.9 to −150.1°F −150.0 to +199.9°F	0.1°F 0.1°F	±1.0°F ±0.4°F
	1100°F	−360 to +1100°F	1°F	±2°F
869	200°C	−199.9 to −150.1°C −150.0 to +199.9°C	0.1°C 0.1°C	±1.5°C ±0.3°C
	630°C	−220 to +630°C	1°C	±1°C

OMEGA 880 DIGITAL MULTIMETER
88.0
OMEGA 881 DIGITAL MULTIMETER
88.1
Multimeters

Model 880
$134

Model 881F
$209
°F Display

Model 881C
$199
°C Display

The OMEGA Models 880 and 881 are fully portable Digital Multimeters designed with a rugged, high impact case to withstand daily field use. These precision DMM's measure dc voltage and current, ac voltage and current, and resistance. In addition, the Model 881 features TRMS ac voltage and current, and TEMPERATURE MEASUREMENT from a type K thermocouple. Both the Model 880 and 881 feature 0.25% accuracy, and the Model 881 is available with either °C or °F temperature readout. Included with both models is a set of general purpose test leads (Kit 880-A10). Model 881 also has a type K beaded wire thermocouple.

MULTIMETER ACCURACY

	dc Voltage	dc Current	ac Voltage*	ac Current*	Resistance
Sensitivity:	100 μV	1 μA	100 μV	1 μA	100 mΩ
Model 880:	±(.25% rdg ± 1 digit)	±(.75% rdg + 1 digit)	±(1% + 3 digits)	±(2% rdg + 2 digits)	±(0.5% rdg + 4 digits)
Model 881:	±(.25% rdg + 1 digit)	±(.75% rdg + 1 digit)	+(1% + 9 digits)	±(2% rdg +9 digit)	±(0.5% rdg + 4 digits)

**TRMS with Model 881*

TEMPERATURE—MODEL 881

Model	Range	Resolution	Accuracy
881F	0 to +2000°F	1°F	+(5°F + 1 digit) up to 225°F
881C	−20 to +1370°C	1°C	+(3°C + 1 digit) up to 150°C

Notes: ±3% rdg over 225°F/150°C, chart correctable to 1.5% rdg over 350°C (600°F)

SERIES 870 THERMOCOUPLE DUAL INPUTS

OMEGA 871 DIGITAL THERMOMETER
87.1
OMEGA 872 DIGITAL THERMOMETER
87.2
TC1
TC2
TC 500V MAX
mV OUT
TYPE K TC
NiCr-NiAl
TYPE J TC
Fe-CuNi

How to Order
In Stock for Immediate Delivery

Model	Input	Range	Price
871	K Chromel/Alumel	−40 to 1999°F −40 to 1370°C	$225
872	J Iron/Constantan	−40 to 1400°F −40 to 760°C	$249

- Type J and K Thermocouples
- Heavy Duty Construction
- 0.25% Accuracy
- Dual Input Configuration
- 0.1° and 1° Resolutions
- Probe Selection Guide on Page C-6

Accessories

TC-GG-[*]-24-36-SMP-M	Thermocouple sensor (supplied with unit) if purchased separately.	**$10.00**
KS-871	Tilt stand	**10.00**
SC-800	Soft carrying case	**10.00**
880-A2	Deluxe carrying case	**25.00**
MN-1604	9 V replacement battery	**3.00**
SMP-[*]-M	Subminiature thermocouple connector, male	**1.75**
SMP-[*]-F	Subminiature thermocouple connector, female	**2.25**
50 ft. EXPP-[*]-20	Thermocouple extension wire, 20 gage, polyvinyl insulation, 50 ft. spool	**30.00**
OT-201-1	2 oz. jar of high thermal conductivity paste for fast surface measurements	**7.50**

Insert thermocouple type: J for **Model 872 K for **Model 871***

Specifications

Accuracy: ±(0.25% of reading + 1°C) for 1 year, 64 to 82°F (18 to 28°C) ambient. Includes NBS conformity, cold junction compensation and repeatability errors. Excludes thermocouple errors.
Repeatability: ±0.2°C typical for one week at constant ambient temperature.
Temperature Coefficient: 64 to 82°F (18 to 28°C): Included in accuracy specification. 32 to 64°F (0 to 18°C) and 82 to 122°F (28 to 50°C). Less than ±(0.025% of reading +0.1°C/°C.
Linearization: Model 871: Multislope A/D with 11 piece-wise linear segments from −40 to +1999°F. Model 872: 9 piece-wise linear segments from −40 to +1400°F.
Display: 3½ digit LCD, 0.6″ (15 mm) height, with polarity, decimal point, overrange and open thermocouple indication.
Reading Rate: 2.5 per second
Battery Life: 100 hours typical with 9 V alkaline battery.
Battery Indicator: Display reads "BAT" when less than 10% of life remains.
mV Output: Non-linearized, cold junction compensated thermocouple output (not isolated from selected thermocouple input).
mV Output Accuracy: 64 to 82°F (18 to 28°C) ambient: ±40 μV (°C ranges) ±80 μV (°F ranges). 0°C = 0.0 mV. Output resistance = 17 KΩ.
Environmental Limits: Operating: 32 to 122°F (0 to 50°C). Storage: −31 to 140°F (−35 to 60°C).
Maximum Common Mode Voltage: 500 V
Dimensions: H: 7.0″ (178 mm) × W: 3.1″ (78 mm) × D: 1.6″ (42 mm).
Net Weight: 10.6 oz. (300 grams).
Accessories supplied: Battery, manual, thermocouple, connector.

See sections A and D for thermocouple probes and handles.

Thermocouple Probe Included

SERIES 860 RTD THERMOMETERS

ΩOMEGA® 868 THERMOMETER
86.8
°F
200
OFF
100 Ω PLATINUM RTD
α = 0.00385
RANGE: −360°F to 1100°F
42V MAX
ΩOMEGA® 869 THERMOMETER
86.9
°C
200
OFF
100 Ω PLATINUM RTD
α = 0.00385
RANGE: −220°C to 630°C
42V MAX

How to Order

In Stock for Immediate Delivery

Model	Display	Range	Price
868	°F	−360 to 1100° F	$249
869	°C	−220 to 630°C	

Note: when ordering 3-wire RTD probes for use with these units, specify "for use with Series 860 RTD Thermometers."

- **3 and 4 wire RTD's**
- **Accurate**
- **1.0° Resolution**
- **Compact and Rugged**
- **DIN 43760 Standard**
- **Probe Selection Guide on Page C-6**

The Model 868 and 869 RTD Thermometers are the first portable digital thermometers for use with both 3 or 4 wire Platinum RTD's.

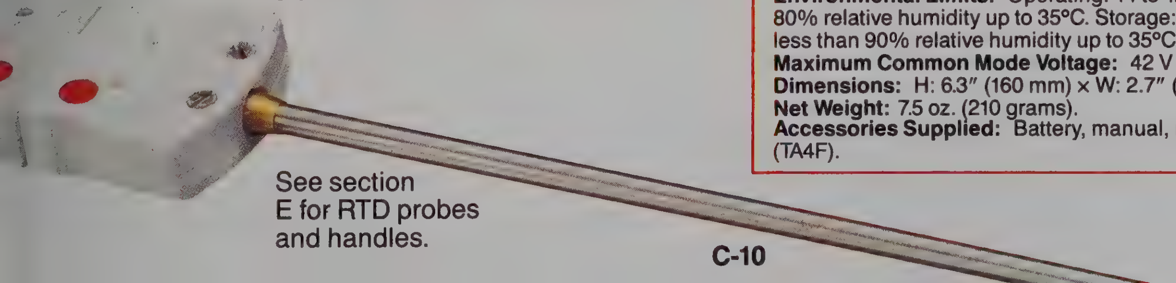
Accessories

KS-860	Tilt stand/belt clip/probe holder	**$10.00**
SC-800	Soft carrying case	**10.00**
880-A2	Deluxe carrying case	**25.00**
TA4F	Series T four wire connector (one supplied)	**4.85**
MN-1604	9 V Replacement battery	**3.00**
50 ft. EXPP-3CU-24S	Extension wire for 3 wire RTD's, 24 gage, polyvinyl insulation, 50 ft.	**50.00**
50 ft. EXTT-4CU-26S	Extension wire for 4 wire RTD's, 26 gage, Teflon insulation, 50 ft.	**99.00**
OT-201-1	2 oz. jar of high thermal conductivity paste for fast surface measurements	**7.50**

Specifications

Sensor: 3 or 4 wire 100 Ω Platinum RTD $\alpha = 0.00385$
Accuracy: See page C-8. Includes DIN 43760 conformity, repeatability, temperature coefficient (18 to 28°C ambient), time stability (1 year) and errors with up to 50 Ω of resistance in each lead. Excludes probe errors.
Repeatability: Less than 0.2°F (0.1°C on 869) typical for one week at constant ambient temperature.
Temperature Coefficient: 64 to 82°F (18 to 28°C): Included in accuracy specification; Below 64°F (18°C), or greater than 82°F (28°C): less than ±(0.015°C)/°C.
Maximum Lead Resistance: 4 wire: 50 Ω Max; 3 wire: 10 Ω Max
Display: 3½ digit LCD, 0.5″ (13 mm) height. Polarity, decimal point, overrange and open sensor indication.
Reading Rate: 1.5 per second.
Battery Life: 500 hours typical, with 9 V alkaline battery.
Battery Indicator: Display indicates "LO BAT" when less than 10% of life remains.
Linearization: Ratiometric dual-slope A/D with continuous linearization.
Input Connection: OMEGA Series T instrumentation connectors (Model No's. TA4F and TA4FL).
Environmental Limits: Operating: 14 to 122°F (−10 to 50°C), less than 80% relative humidity up to 35°C. Storage: −31 to 140°F (−35 to 60°C), less than 90% relative humidity up to 35°C.
Maximum Common Mode Voltage: 42 V peak.
Dimensions: H: 6.3″ (160 mm) × W: 2.7″ (69 mm) × D: 1.2″ (31 mm)
Net Weight: 7.5 oz. (210 grams).
Accessories Supplied: Battery, manual, mating input connector (TA4F).

Probe Not Included



See section E for RTD probes and handles.

SERIES 860 THERMISTORS

OMEGA 865 THERMOMETER
86.5
°F
OMEGA 866 THERMOMETER
86.6
°C

How to Order

In Stock for Immediate Delivery

Model	Display	Range	Price
865	°F	−70 to 300°F	$139
866	°C	−55 to 150°C	

- **Series 400 Thermistors**
- **Rugged**
- **0.1° Resolution**
- **Economical and Accurate**
- **Probe Selection Guide on Page C-6**

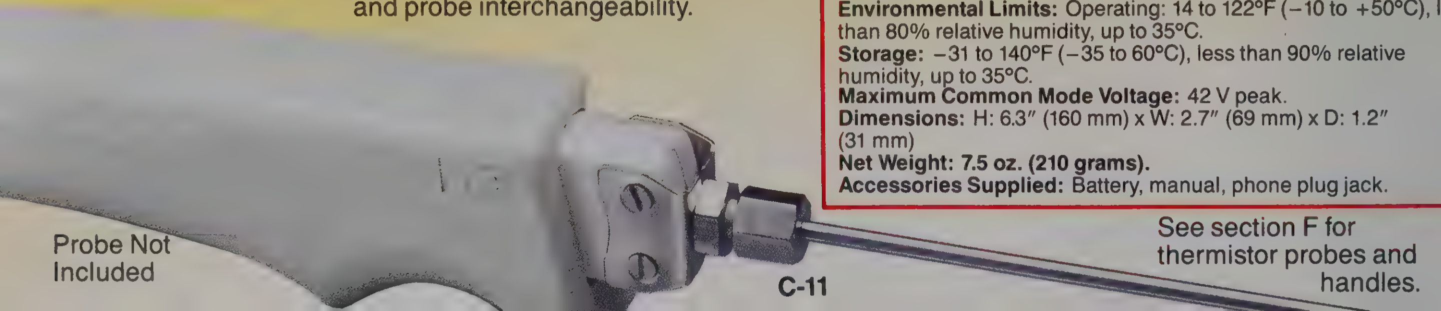
The Model 865 and 866 Thermistor Thermometers offer exceptional values combining thermistor accuracy, heavy duty construction, and probe interchangeability.

Accessories

KS-860	Tilt stand/belt clip/probe holder	$10.00
SC-800	Soft carrying case	10.00
880-A2	Deluxe carrying case	25.00
PPM-2	Mating phone plug	2.50
MN-1604	9 V replacement battery	3.00
50 ft. EXPP-2CU-24S	Extension wire for Series 400 thermistors, 24 gage polyvinyl insulation, 50 ft.	50.00
OT-201-1	2 oz. jar of high thermal conductivity paste for fast surface measurements	7.50

Specifications

Sensor: OMEGA Series 400 Thermistor (2252 Ω @ 25°C)
Accuracy: See page C-7. Includes repeatability, temperature coefficient (18 to 28°C ambient), time stability (1 year) and linearization conformity errors. Excludes probe errors.
Repeatability: 0.2°F (0.1°C) typical for one week at constant ambient temperature.
Temperature Coefficient: 64 to 82°F (18 to 28°C); included in accuracy specification. Less than 64°F (18°C) or greater than 82°F (28°C); less than +(0.06% rdg + 0.01°C)/°C
Linearization: Ratiometric dual slope A/D with continuous linearization.
Input Connection: ¼″ phone jack.
Display: 3½ digit LCD, 0.5″ (13 mm) height. Polarity, decimal point, open sensor and overrange indication.
Reading Rate: 1.5 per second.
Battery Life: 350 hours typical, with 9 V alkaline battery.
Battery Indicator: Display reads "LO BAT" when less than 10% of life remains.
Environmental Limits: Operating: 14 to 122°F (−10 to +50°C), less than 80% relative humidity, up to 35°C.
Storage: −31 to 140°F (−35 to 60°C), less than 90% relative humidity, up to 35°C.
Maximum Common Mode Voltage: 42 V peak.
Dimensions: H: 6.3″ (160 mm) x W: 2.7″ (69 mm) x D: 1.2″ (31 mm)
Net Weight: 7.5 oz. (210 grams).
Accessories Supplied: Battery, manual, phone plug jack.



Probe Not Included

See section F for thermistor probes and handles.

SERIES 880 MULTIMETERS

How to Order

In Stock for Immediate Delivery

Model	AC	Temperature Range	Price
880	Average Responding		$134
881C	TRMS	−20 to 1370°C	$199
881F	TRMS	0 to 2000°F	$209

The Model 880 and 881 Multimeters are rugged, portable instruments, accurate for use in the laboratory as well as in the field.

OMEGA 881F DIGITAL MULTIMETER
88.1
DCA
TEMP
ACA
COM
V-Ω
mA
TYPE K TC
OMEGA 880 DIGITAL MULTIMETER
88.0
DCV
ACV
DCA
ACA
mA
COM
10A HI
10A COM

FREE!
Probes Included

Beaded wire thermocouple included with model 881

General purpose test lead set included with both Models 880 and 881.

SERIES 880 SPECIFICATIONS

Temperature Sensor: Type K (Chromel/Alumel) thermocouple.
Overload Protection: 150 V continuous, 300 V momentary (10 sec.).
Display: 3½ digit LCD, 0.6" (15 mm) height, with polarity, decimal point and overrange indication.
Maximum Common Mode Voltage: 500 V peak.
Environmental Limits: Operating: 32 to 122°F (0 to 50°C) less than 80% relative humidity up to 35°C (70% humidity with Model 880). Storage: -31 to 140°F (-35 to 60°C) less than 90% relative humidity up to 35°C (70% humidity with Model 880).
Temperature Coefficient: 64 to 82°F (18 to 28°C): Included in accuracy specifications. Less than 64°F (18°C) or greater than 82°C (28°F): Less than 0.1 x applicable accuracy specification per °C.
Battery Life: 200 hrs. typical with 9 V alkaline battery (150 hrs. Model 881).
Battery Indicator: Display indicates "BAT" when less than 10% of life remains.
Dimensions: H: 7.0" (178 mm) x W: 3.1" (78 mm) x D: 1.6" (42 mm) Model 880: D: 1.5" (38 mm)
Net Weight: Model 880: 10 oz. (283 grams), Model 881: 13 oz. (370 grams).
Accessories Supplied: Battery, manual, general purpose test lead set (Model 880-A10). Model 881 only: thermocouple sensor (Model TC-GG-K-24-36-SMP-M), connector.

DC Voltage

Setting	Resolution	Accuracy
200 mV	100 μV	±(0.25% reading to 1 d)
2 V	1 mV	
20 V	10 mV	
200 V	100 mV	
1000 V	1 V	

Max. Allowable Input: 1000 V dc
Input resistance: 10 MΩ
Normal Mode Rejection Ratio: greater than 46 dB at 50 Hz, 60 Hz.
Common Mode Rejection Ratio: greater than 100 dB at dc, 50 Hz and 60 Hz (1K Ω unbalance).

DC Current:

Setting	Resolution	Accuracy	Maximum Full Scale Voltage Burden
2 mA	1μA	±(0.75% reading + 1 digit)	0.25 V
20 mA	10μA	±(0.75% reading + 1 digit)	0.25 V
200 mA	100μA	Model 880: ±(.75% rdg + 1 digit)	0.25 V
		881: ±(1.0% rdg + 1 digit	0.25 V
2000 mA	1 mA	±(2% reading + 1 digit)	0. 7 V
10A*	10 mA	±(2% reading + 1 digit)	0. 3 V

*880 only

Overload protection: mA ranges: 2A fuse (250 V) externally accessible; 10A range: 20A for 15 sec. unfused.

ACCESSORIES

All 800 Series Accessories are in Stock for Immediate Delivery!

880-A6
880-A7
SC-800
880-A

AC VOLTAGE (TRMS Model 881)

Setting	Resolution	Accuracy	Frequency Range
200 mV	100µV		
2 V	1mV	Model 880: ±(1% reading + 3 digits)	
20 V	10 mV	881: ±(1% reading + 9 digits)	45-500 Hz
200V	100 mV		
750V	1 V		

Maximum Allowable Input: 1000 V ac peak non-switched, 750 V ac peak switched; continuous except 200 mV range: 15 sec. max above 300 V ac.
Input Impedance: 10 M Ω shunted by less than 100pF.
Response: Model 880: average responding, calibrated in RMS of a sine wave. Model 881: True Root Mean Square; AC coupled.

Crest factor (Model 881 only): Up to 3:1 allowable. Less than 2% additional error, 50 Hz or 60 Hz rectangular pulse train with crest factor of 3:1.

AC CURRENT(TRMS Model 881)

Setting	Resolution	Accuracy	Maximum Full Scale Voltage Burden
2 mA	1µA	±(2% rdg + 2 digits) ±(2% rdg + 9 d)**	0.25 V
20 mA	10µA	±(2% rdg + 2 digit) ±(2% rdg + 9 d)**	0.25 V
200 mA	100µA	±(2% rdg + 2 digits) ±(2% rdg + 9 d)**	0.25 V
2000 mA	1 mA	±(3% rdg + 5 digits) ±(3% rdg + 9 d)**	0. 7 V
10 A* *880 only	10 mA	±(3% rdg + 5 digits) **Model 881	0. 3 V

Overload protection: mA ranges: 2A fuse (250 V) externally accessible; 10 A range: 20A for 15 sec. unfused.
Response: Model 880: average responding, calibrated in RMS of a sine wave. Model 881: True Root Mean Square; AC coupled

RESISTANCE

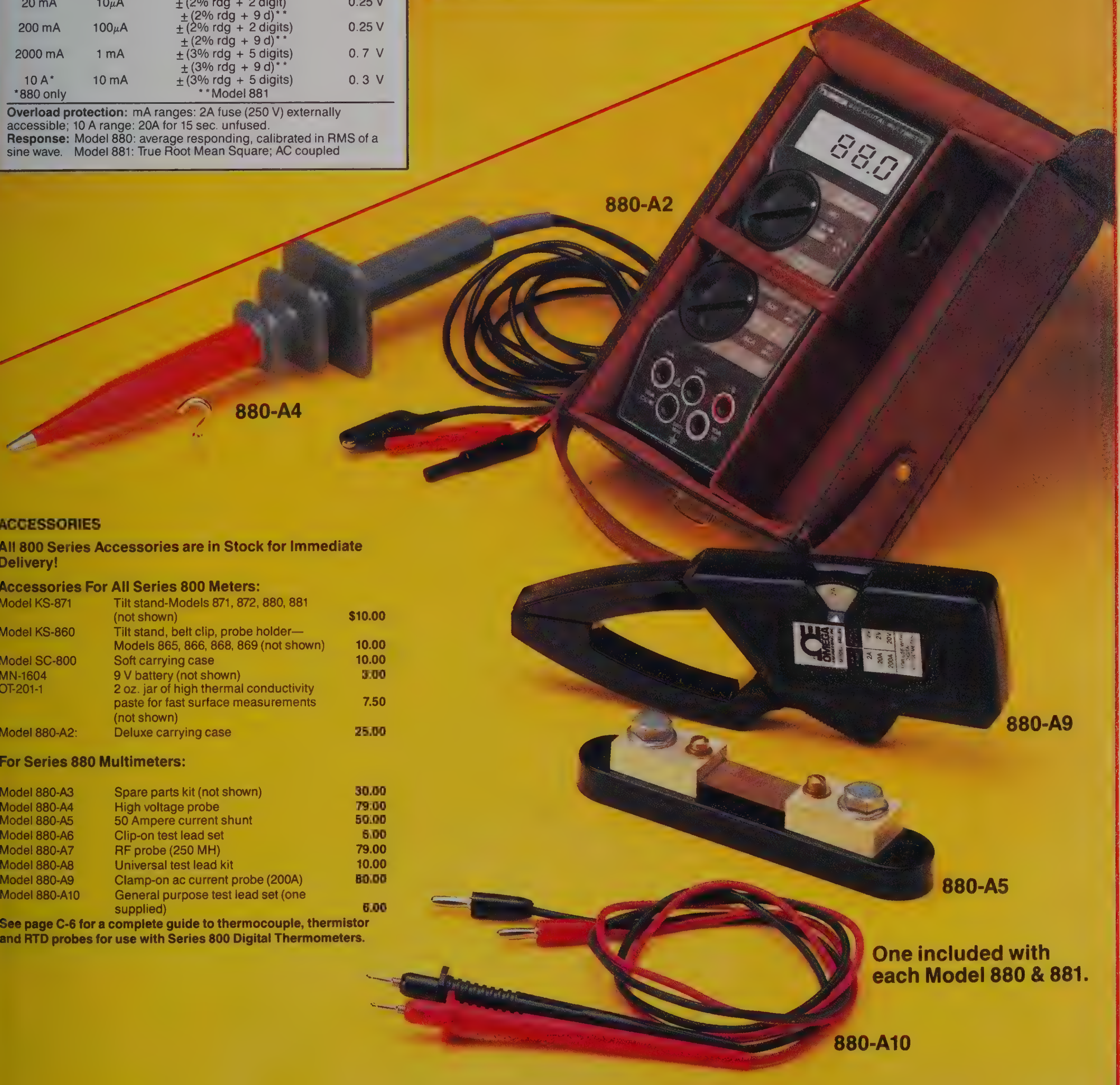
Setting	Resolution	Accuracy	Full Scale Voltage
200 Ω	100 m Ω	±(0.5% rdg + 4 digits)	< 0.5 V
2 k Ω	1 Ω	±(0.2% rdg + 1 digit)	< 0.7 V
20 k Ω	10 Ω	±(0.2% rdg + 1 digit)	> 0.7 V
200 k Ω	100 Ω	±(2.0% rdg + 1 digit)	> 0. 7 V
20MΩ	10 k Ω		> 0. 7 V

Max. Open Circuit Voltage: 1.5 V
Max. Allowable Input: 300 V dc or RMS

TEMPERATURE* (Model 881 only)

Model	Range	Resolution	Accuracy
881 F	0 to 2000°F	1°F	±(5°F + 1 digit) up to 225°F; +3% rdg over 225°F.*
881 C	−20 to +1370°C	1°C	±(3°C + 1 digit) up to 150°C; ±3% rdg over 150°C.*

***Chart correctable to ± 1.5% rdg over 350°C (600°F). Includes NBS conformity, calibration stability, zero and reference junction, but not thermocouple errors.**



One included with each Model 880 & 881.

ACCESSORIES

All 800 Series Accessories are in Stock for Immediate Delivery!

Accessories For All Series 800 Meters:

Model KS-871	Tilt stand-Models 871, 872, 880, 881 (not shown)	$10.00
Model KS-860	Tilt stand, belt clip, probe holder—Models 865, 866, 868, 869 (not shown)	10.00
Model SC-800	Soft carrying case	10.00
MN-1604	9 V battery (not shown)	3.00
OT-201-1	2 oz. jar of high thermal conductivity paste for fast surface measurements (not shown)	7.50
Model 880-A2:	Deluxe carrying case	25.00

For Series 880 Multimeters:

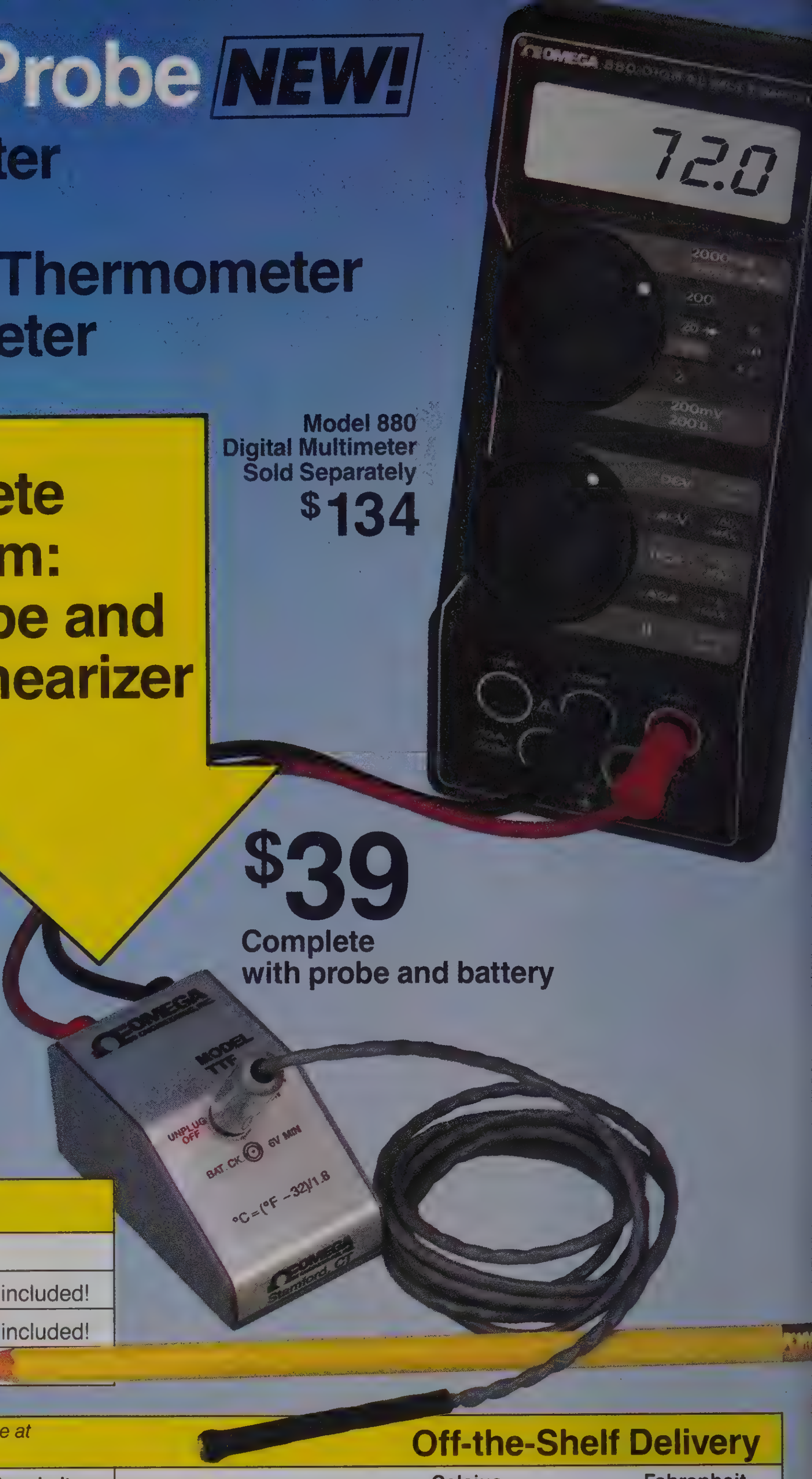
Model 880-A3	Spare parts kit (not shown)	30.00
Model 880-A4	High voltage probe	79.00
Model 880-A5	50 Ampere current shunt	50.00
Model 880-A6	Clip-on test lead set	6.00
Model 880-A7	RF probe (250 MH)	79.00
Model 880-A8	Universal test lead kit	10.00
Model 880-A9	Clamp-on ac current probe (200A)	80.00
Model 880-A10	General purpose test lead set (one supplied)	6.00

See page C-6 for a complete guide to thermocouple, thermistor and RTD probes for use with Series 800 Digital Thermometers.

Temperature Probe **NEW!**

With Millivolt Converter

Makes an Electronic Thermometer out of any Millivolt Meter



Complete System: Probe and Linearizer

Model 880
Digital Multimeter
Sold Separately
$134

$39
Complete
with probe and battery

Features:

- 1 mV/Degree output for easy temperature reading
- Probe lead extendable without error
- High accuracy and rapid response
- Low power for long battery life
- Water resistant probe with 4′ ultra flexible lead
- Probe input jack activates power—permits easy lead extension and battery test

How to Order: Specify Catalog Number

Catalog No.	Temperature Range	Price
Model TTC	−55°C to +150°C	**$39** Probe included!
Model TTF	−67°F to +302°F	**$39** Probe included!
MN-1604	Replacement Battery	$3

Specifications: *(Typical with sensor and module at +25°C and new battery)*

Off-the-Shelf Delivery

	Celsius Model TTC	Fahrenheit Model TTF
PROBE—SOLID STATE SENSOR		
Max. Temperature		
Intermittent	+150°C	+302°F
Continuous	+135°C	+275°F
Cable	+105°C	+221°F
Min. Temperature	− 55°C	− 67°F
Max. Nonlinearity (Includes Module)	±2.0°C	±3.6°F
Breakdown Voltage	±200 V (Either Lead to Case)	
Tip Diameter	0.165 in. (4.19 mm)	
Length	2 in. (50.8 mm)	
Lead Length	48 in. (122 cm)	

	Celsius Model TTC	Fahrenheit Model TTF
MODULE		
Output	1 mV/°C	1 mV/°F
Accuracy	±0.3°C	±0.5°F
MODULE		
Min. DMM Impedance	1MΩ	1MΩ
Approx. Battery Life	300 Hrs.	300 Hrs.
Input Jack	Miniature Phone	
Output Jacks	Miniature Test Leads	
Dimensions	2.5″ L × 1.5″ W × 1.25″ H 63.5 mm × 38.1 mm × 31.7 mm	
Weight (with battery)	3.30 oz. (93.5 gm)	

Hand Held Thermometers

Digital Series 450

New precision Thermocouple, Thermistor, and RTD portable temperature indicators for industrial and laboratory applications.

Available for Immediate Delivery!

$275

(Meter shown actual size)

Compact!
Accurate!
Rugged!

210.7°F
OMEGA
450 AET
THERMOCOUPLE THERMOMETER
TYPE E
HOLD
OFF
1°
0.1°
ON
°F
ON
°C
TEMPERATURE INDICATOR

Hand Held Thermometers

Digital Series 450

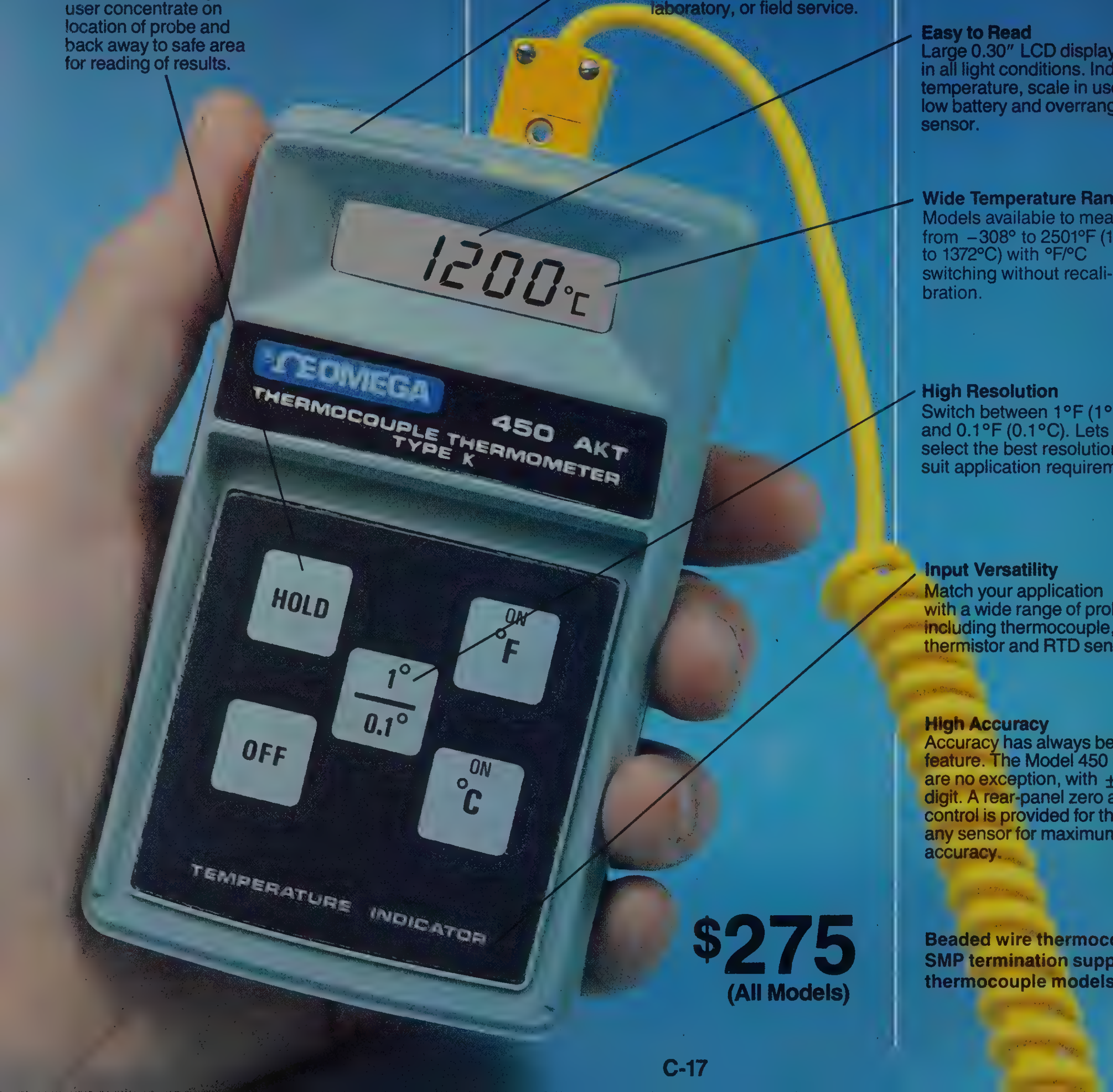
The Series 450 Digital Thermometers offer these advantages:

- **Patented Noise Reduction Circuit** The analog IC, in addition to requiring very low power, must amplify exceedingly small signals—approximately 5 microvolts—and convert them to digital signals.

  Only a few commercially available converters can work at these low power levels, and none have been capable of measuring low magnitude microvolt signals. The Series 450 custom analog IC uses a unique, patented, noise reduction circuit to allow its amplifier to process the signals with high accuracy and reliability. This gives the user a single instrument with wide temperature range, resolution to 0.1°F/°C and long-term performance.

- **2,000 Hours on One Battery** The Series 450 can operate in excess of 2,000 hours continuously on a single 9-volt transistor radio battery! No recharging is required. Under normal use, this equals over one year of operation.

- **Multifunction Linearization** The Series 450 digital IC processes the sensor input using a linearization method that is a piece-wise linear approximation to the exact curve, using typically 100 segments per curve. Thus, high accuracy and performance are achieved.



Snapshot Readings
Press the "hold" button to capture the last instrument reading. Lets user concentrate on location of probe and back away to safe area for reading of results.

Rugged Reliability
Custom molded, high-impact case is designed for environments of industry, laboratory, or field service.

Easy to Read
Large 0.30" LCD display is readable in all light conditions. Indicates temperature, scale in use (°F or °C), low battery and overranged or "open" sensor.

Wide Temperature Range
Models available to measure from −308° to 2501°F (189° to 1372°C) with °F/°C switching without recalibration.

High Resolution
Switch between 1°F (1°C) and 0.1°F (0.1°C). Lets user select the best resolution to suit application requirements.

Input Versatility
Match your application with a wide range of probes, including thermocouple, thermistor and RTD sensors.

High Accuracy
Accuracy has always been an OMEGA feature. The Model 450 instruments are no exception, with ±0.10% rdg ±1 digit. A rear-panel zero adjustment control is provided for the user to adjust any sensor for maximum system accuracy.

$275
(All Models)

Beaded wire thermocouple with SMP termination supplied with thermocouple models.

Precision for Thermocouples

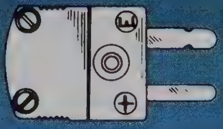
Model 450-AKT

For use with Type K (Chromel-Alumel) Thermocouples

K The precision Model 450-AKT covers a wide temperature range for full utilization of type K thermocouples. High accuracy (0.1%), display hold, °F/°C switchability and 1° or 0.1° resolution have all been designed into a rugged, industrial case, small enough to fit into a shirt pocket.

When combined with OMEGA standard type K thermocouple probes, the Model 450-AKT forms an accurate, high or low temperature measurement system. Probes are available for surface, liquid immersion, air/gas measurements and thousands of specialty applications. General purpose, industrial, electronics and HVAC are areas where the 450-AKT measurement systems excel.

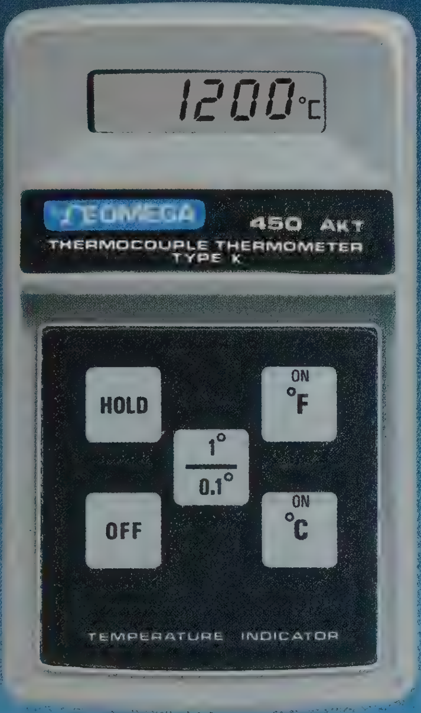
The Model 450-AKT will work with any type K Thermocouple Probe fitted with a miniature (NMP) or a subminiature (SMP) Thermocouple Connector. A mating subminiature connector is supplied with the instrument. For more information on thermocouple probes, refer to Sections A and D.



Mating subminiature thermocouple connector SMP-K-M supplied with instrument. Extra connectors, **$1.75** each.

Range Designator

Input	Range	Resolution	Accuracy
Type K Thermocouple	–308° to 2501°F	1.0°F	±1.5°F ±0.1% rdg
	–189° to 1372°C	1.0°C	±0.8°C ±0.1% rdg
	–220° to 398°F	0.1°F	±0.5°F ±0.1% rdg
	–140° to 203°C	0.1°C	±0.3°C ±0.1% rdg



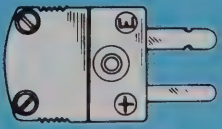
$275

Model 450-AET

E Now a precision hand-held instrument Model 450-AET to work with type E thermocouples. The Model 450-AET combines high accuracy (0.1% of reading), °C/°F switchability, 1° and 0.1° resolution and display hold in a small, rugged case.

Type E thermocouple probes are available from OMEGA for general purpose, surface measurement, air/gas measurement and liquid immersion. Type E thermocouple's high output, low limits of error and corrosion resistance make them ideally suited for many laboratory, industrial, electronics and HVAC applications. When combined with the Model 450-AET, they form a versatile, accurate temperature measurement system.

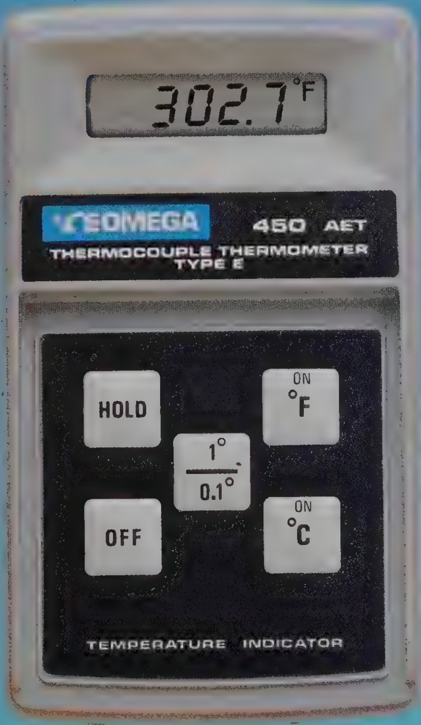
The Model 450-AET will work with any type E thermocouple probe fitted with a miniature (NMP) or a subminiature (SMP) thermocouple connector. A mating subminiature connector is supplied with the instrument. For more information on thermocouple probes, refer to Sections A and D.



Mating subminiature thermocouple connector SMP-E-M supplied with the instrument. Extra connectors, **$1.75** each.

Range Designator

Input	Range	Resolution	Accuracy
Type E Thermocouple	–350° to 1844°F	1.0°F	±1.5°F ±0.1% rdg
	–212° to 1006°C	1.0°C	±0.8°C ±0.1% rdg
	–215° to 398°F	0.1°F	±0.5°F ±0.1% rdg
	–137° to 203°C	0.1°C	±0.3°C ±0.1% rdg

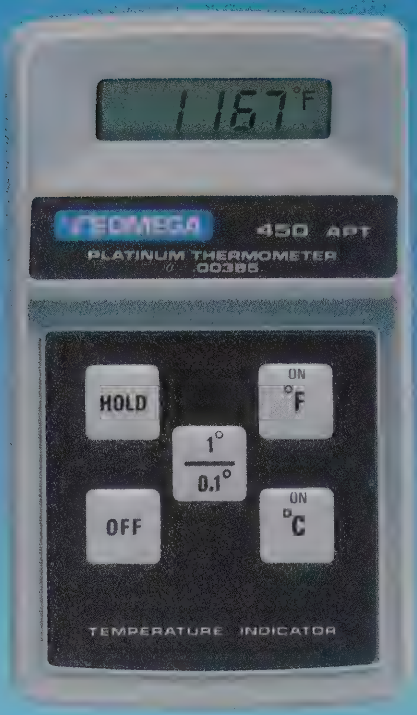


$275

Hand Held Thermometers

Digital Series 450

Precision for RTD's and Thermistors



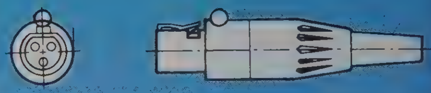
$275

Model 450-APT

OMEGA Model 450-APT Platinum Thermometer is for applications requiring the precision and temperature range of Platinum Resistance Thermometers.

This rugged precision hand held instrument features °F/°C switchability, 0.1° and 1.0° resolution and an easy-to-read LCD display with a "Hold" mode.

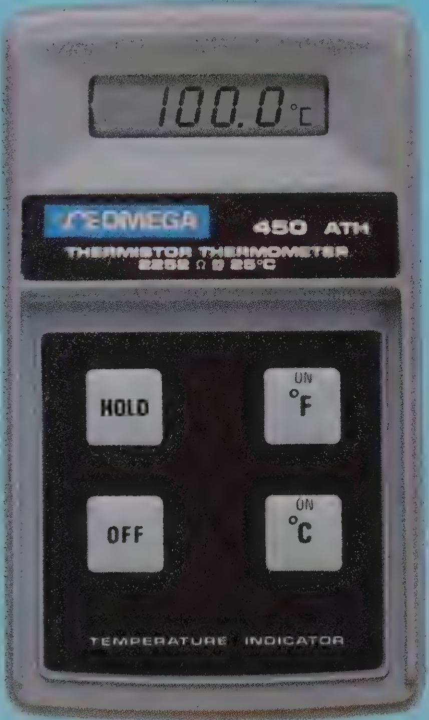
The Model 450-APT RTD Thermometer will accept any OMEGA 3-wire, 100 ohm ($\alpha = 0.00385$) platinum RTD which is fitted with an OMEGA "T" Series Instrumentation Connector (Catalog Numbers TA3F and TA3FL). These connectors are shown in Section G. A mating TA3F Connector is supplied with the instrument. For more information on RTD probes, refer to Section E.



Mating RTD connector TA3F supplied with instrument. Extra connectors, **$4.65** each.

Range Designator

Type of Input	Range	Resolution	Accuracy
100 Ω Platinum RTD α = 0.00385	–388° to 1600°F	1.0°F	±1.5°F ±0.1% rdg
	–233° to 904°C	1.0°C	±0.8°C ±0.1% rdg
	–153° to 398°F	0.1°F	±0.5°F ±0.1% rdg
	–102° to 203°C	0.1°C	±0.3°C ±0.1% rdg

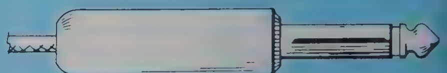


$275

Model 450-ATH

OMEGA Model 450-ATH Thermistor Thermometer is available for applications requiring high resolution and long-term accuracy and stability.

The thermometer accepts the standard OMEGA Series "400" Thermistor Probes with various configurations ideally suited for fast-response laboratory or environmental science applications. Standard features include °F/°C switchability, 0.1°F/°C resolution, and display hold. Probes are connected through a quick disconnect ¼″ phone jack. A mating phone plug PPM-2 is supplied with the instrument. For more information on thermistor probes, refer to Section F.



Mating phone plug PPM-2 is supplied with the instrument. Extra phone plug, **$2.50** each.

Range Designator

Type of Input	Range	Resolution	Accuracy
OMEGA 400 Thermistor	–14° to 217°F	0.1°F	±0.45°F ±0.1% rdg
	–25° to 103°C	0.1°C	±0.25°C ±0.1% rdg

Range Designator

NEW!

$275

Type of Input	Range	Resolution	Accuracy
Model 450 – ATT for Type T Thermocouples	–360° to 758°F	1.0°F	±1.5°F ±0.1% rdg
	–217° to 403°C	1.0°C	±0.8°C ±0.1% rdg

Specifications

32.0°F
OMEGA
450 ATH
THERMISTOR THERMOMETER
2252 Ω @ 25°C
HOLD
ON °F
OFF
ON °C
TEMPERATURE INDICATOR

Off-the-Shelf Delivery

Sensor Types: Type E and type K Thermocouple, OMEGA Series 400 Thermistor, Platinum 100 ohm, 3-wire RTD, ($\alpha = 0.00385$)
Display: 0.30″ LCD
Accuracy/Resolution: Please refer to range table
Indication: °F/°C selectable
Operating Range: 0° to 50°C ambient
Accuracy over Time: 90 days: add ±0.05% rdg
1 year: add 0.1% rdg
Temperature Drift: Zero: ±2 µV/C
Span: ±0.02%/°C
Probe Connection: Standard OMEGA Subminiature Connector (thermocouple); ¼″ Phone Jack (Thermistor); OMEGA Mini RTD Connector (RTD)
Storage Temperature: −20°C to +70°C
Normal Mode Rejection: 50 dB at 50 Hz or 60 Hz
Common Mode Rejection: 140 dB at 50 Hz or 60 Hz
Maximum Common Mode Voltage: 1000 Vac, ±2000 V peak
Measurement Technique: Dual-slope A/D conversion
Linearization: 100% digital. Typically 100 segments, depending on range selected.
Reference Junction Stability with Temperature:
Thermocouple: ±0.7°C from 5°C to 45°C
±1.3°F from 41°F to 113°F
Input Resistance: Thermocouple: 13 MΩ
Thermistor: 698Ω
RTD: 21.2KΩ
Update Rate: 2 readings/second typical
Battery: 9-volt alkaline transistor (Cat. No. MN 1604)
Battery Life: In excess of 2,000 continuous hours for thermocouple; 1,200 hours for thermistor; 500 hours for RTD
Dimensions: H: 7.0″ (178 mm) × W: 3.3″ (84 mm) × D: 1.8″(46 mm)
Weight: 9 oz. (255 grams)

Accessories/OMEGA Series 450

SC-450S	Small Soft Case—a protective soft case for the Model 450. Dimensions: H: 2.0″ (51 mm) × W: 3.5″ (89 mm) x D: 6.0″ (152 mm)	\$10^{00}
SC-450L	Large Soft Case—a protective soft case with room for the Model 450, probes up to 9″ long and other accessories. Dimensions: H: 2.0″ (51 mm) × W: 4.0″ (102 mm) × D: 10.0″ (254 mm)	12^{00}
MN1604	Replacement Battery, 9V, Alkaline	3^{00}
SMP-[ ]-M	Subminiature Thermocouple Alloy Connector, Male. Insert type E or K.	1^{75}
SMP-[ ]-F	Subminiature Thermocouple Alloy Connector, Female. Insert type E or K.	2^{25}
50ft-EXPP-[ ]-20	Thermocouple Extension Wire, 20 gage, Polyvinyl Insulation, 50-ft. spool. Insert type E or K.	30^{00}
OT201-2	2 oz. jar of High-thermal Conductivity Paste for fast surface measurements.	7^{50}

Ordering Information:

1. Select digital thermometer for your application.

Model 450-AET	For use with type E (Chromel-Constantan) Thermocouples.
Model 450-AKT	For use with type K (Chromel-Alumel) Thermocouples.
Model 450-ATH	For use with OMEGA Series 400 Thermistors (2552Ω @ 25°C)
Model 450-APT	For use with 100 ohm, 3-wire Platinum RTD's ($\alpha = 0.00385$.)

All Models: \$275

2. Designate probe style required. Sections A, B and D describe a wide selection of Thermocouple Probes; Section E contains RTD Probes; and Section F covers Thermistor Probes.
3. Select additional accessories.
4. Contact OMEGA directly if there is any further information required.

Design and specifications are subject to change as engineering improvements allow.

Digital Thermometers

Two Affordable Hand Helds

Put one in your tool box!

$99

THERMOCOUPLE
DIGITAL THERMOMETER
°F
88
°C
RANGE: −25°F TO +500°F
−32°C TO +260°C
HH-99J
OMEGA
ENGINEERING, INC.

Shown Actual Size

NEW!

- Lowest Price
- J Iron/Constantan Input
- K Chromel/Alumel Input
- 1% Accuracy ±0.8°C
- Broad Temperature Range
- °C/°F Switchable
- Battery Included

HPS-ICIN-14G-12 inch Handle Probe not included

$36

Protective Carrying Case SC-871

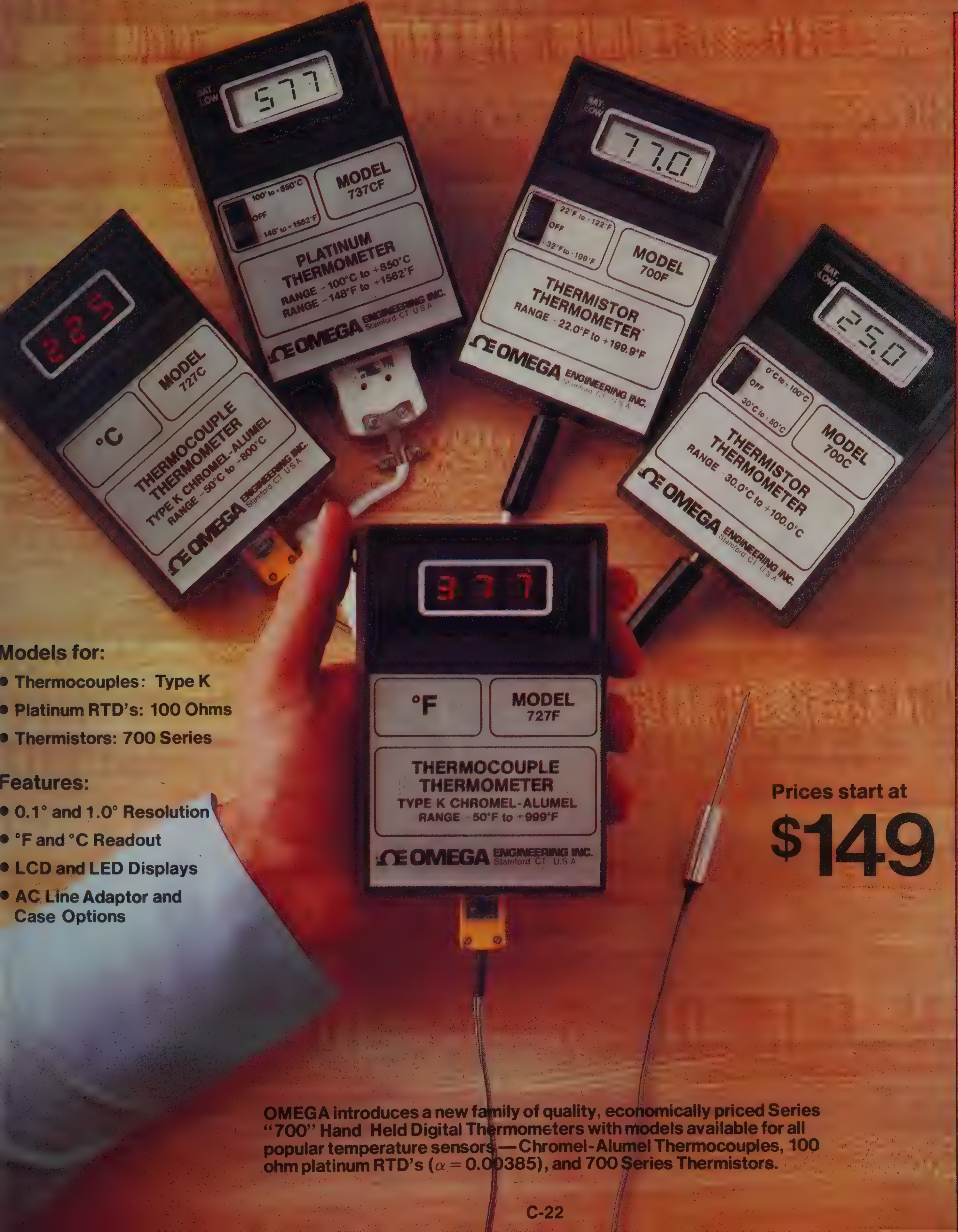
$10

FREE!
Beaded Wire Thermocouple provided with both models

In Stock for Immediate Delivery

Input	Range	Model
J	−25°F to 500°F −32°C to 260°C	HH99J
K	−5°F to 1000°F −20°C to 540°C	HH99K

700 Series Low Cost Hand-Held Precision Digital Thermometers


577
MODEL 737CF
100° to -850°C
OFF
148° to +1562°F
PLATINUM THERMOMETER
RANGE -100°C to +850°C
RANGE -148°F to +1562°F
OMEGA ENGINEERING INC. Stamford CT USA
77.0
MODEL 700F
22°F to 122°F
OFF
32°F to 199°F
THERMISTOR THERMOMETER
RANGE 22.0°F to +199.9°F
225
MODEL 727C
°C
THERMOCOUPLE THERMOMETER
TYPE K CHROMEL-ALUMEL
RANGE -50°C to +800°C
25.0
MODEL 700C
0°C to 100°C
OFF
30°C to 50°C
THERMISTOR THERMOMETER
RANGE 30.0°C to +100.0°C
377
°F
MODEL 727F
THERMOCOUPLE THERMOMETER
TYPE K CHROMEL-ALUMEL
RANGE -50°F to +999°F
OMEGA ENGINEERING INC. Stamford CT USA

Models for:

- Thermocouples: Type K
- Platinum RTD's: 100 Ohms
- Thermistors: 700 Series

Features:

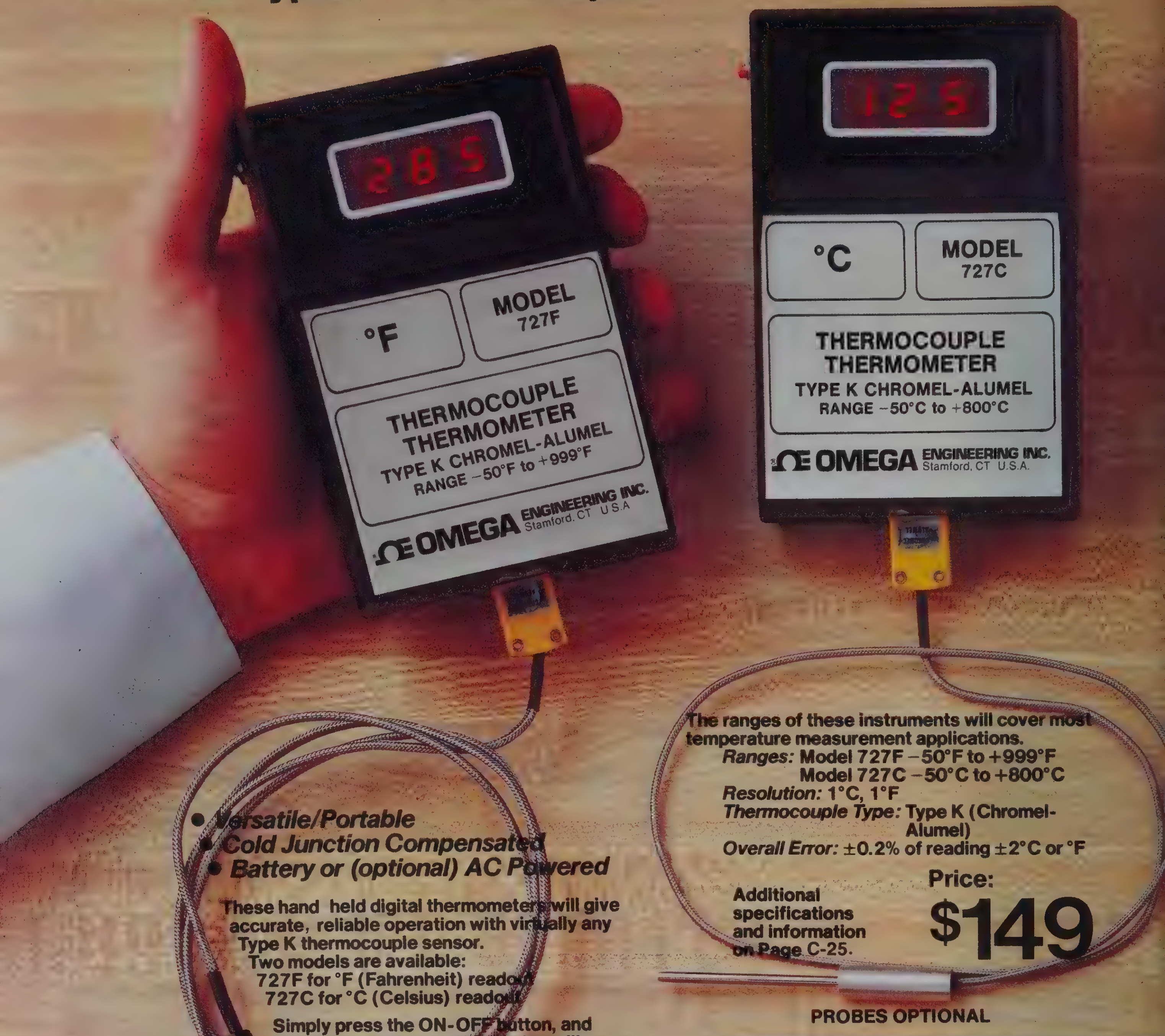
- 0.1° and 1.0° Resolution
- °F and °C Readout
- LCD and LED Displays
- AC Line Adaptor and Case Options

Prices start at

$149

OMEGA introduces a new family of quality, economically priced Series "700" Hand Held Digital Thermometers with models available for all popular temperature sensors—Chromel-Alumel Thermocouples, 100 ohm platinum RTD's ($\alpha = 0.00385$), and 700 Series Thermistors.

Model 727 Hand Held Digital Thermometer for Type K Thermocouples


285
°F
MODEL
727F
THERMOCOUPLE
THERMOMETER
TYPE K CHROMEL-ALUMEL
RANGE −50°F to +999°F
OMEGA ENGINEERING INC.
Stamford, CT U.S.A.
125
°C
MODEL
727C
THERMOCOUPLE
THERMOMETER
TYPE K CHROMEL-ALUMEL
RANGE −50°C to +800°C
OMEGA ENGINEERING INC.
Stamford, CT U.S.A.

- ***Versatile/Portable***
- ***Cold Junction Compensated***
- ***Battery or (optional) AC Powered***

These hand held digital thermometers will give accurate, reliable operation with virtually any Type K thermocouple sensor.

Two models are available:
727F for °F (Fahrenheit) readout
727C for °C (Celsius) readout

Simply press the ON-OFF button, and the high-efficiency LED display will promptly provide a bright, easy-to-read 1°C or °F resolution reading.

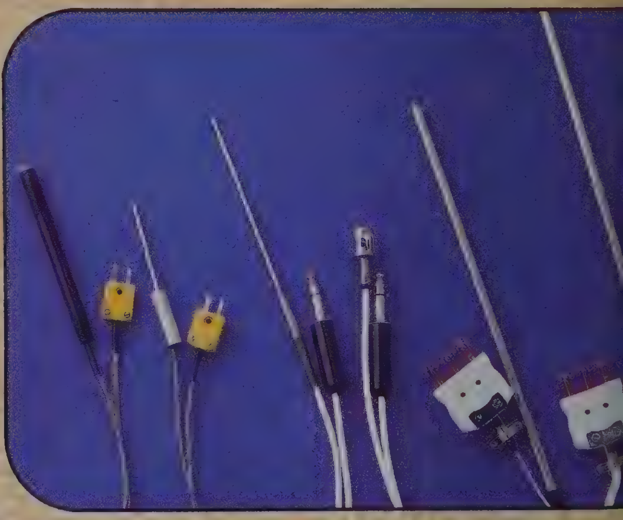
The rugged, high-impact plastic case is fitted with an OMEGA SMP compensated miniature female thermocouple connector for easy connection to OMEGA thermocouple probes. Six AA batteries are rated for 20 hours continuous service, or hundreds of short duration readings.

The ranges of these instruments will cover most temperature measurement applications.

Ranges: **Model 727F −50°F to +999°F**
Model 727C −50°C to +800°C
Resolution: **1°C, 1°F**
Thermocouple Type: **Type K (Chromel-Alumel)**
Overall Error: **±0.2% of reading ±2°C or °F**

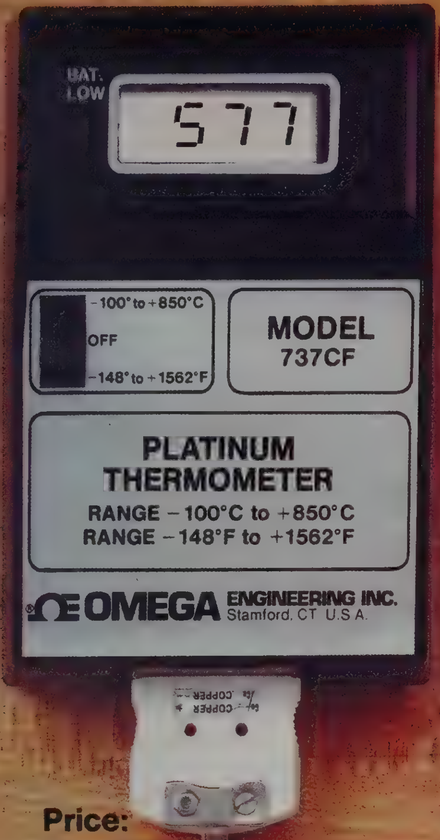
Additional specifications and information on Page C-25.

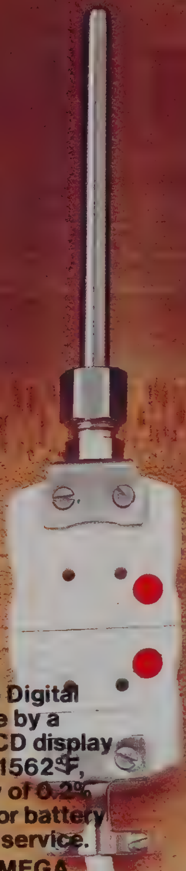
Price:
$149

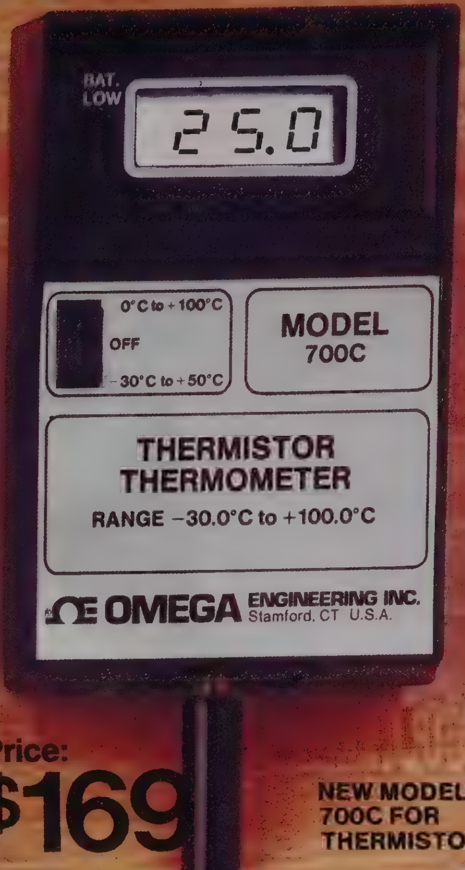


PROBES OPTIONAL

Models 700 and 737 Hand Held Digital Thermometers for Thermistors and Platinum RTD's


BAT. LOW
577
-100° to +850°C
OFF
-148° to +1562°F
MODEL 737CF
PLATINUM THERMOMETER
RANGE -100°C to +850°C
RANGE -148°F to +1562°F
OMEGA ENGINEERING INC. Stamford, CT U.S.A.
COPPER




BAT. LOW
25.0
0°C to +100°C
OFF
-30°C to +50°C
MODEL 700C
THERMISTOR THERMOMETER
RANGE -30.0°C to +100.0°C
OMEGA ENGINEERING INC. Stamford, CT U.S.A.

Price:
$179

NEW MODEL 737CF FOR 100 OHM PLATINUM RTD's

This precision Model 737CF Hand Held Digital reads in either °F or °C, easily selectable by a rocker-type switch. An easy-to-read LCD display covers the full RTD range of −148°F to 1562°F, and −100°C to 850°C, with an accuracy of 0.2% of readings ±1°C or °F. A 9 volt transistor battery offers 100 hours of convenient, reliable service.

Model 737CF is compatible with ALL OMEGA 100 ohm, three-wire platinum RTD probes ($\alpha = 0.00385$) (see Section E). Each instrument is fitted with an OMEGA OTP polarized RTD female connector. When ordering RTD probes, specify "probe to be supplied with OTP-CU-M connector."

PROBES OPTIONAL

Price:
$169

NEW MODELS 700F and 700C FOR THERMISTORS

These rugged, versatile instruments, with ranges of −22.0 °F to +199.9°F (Model 700F) and −30.0°C to +100.0°C (Model 700C) are perfect for making lower temperature measurements. They have an accuracy of ±0.85°F or ±0.5°C, with a 0.1°C or °F resolution.

The easy-to-read LCD display is powered by readily available 9-volt transistor batteries rated for 200 hours continuous service.

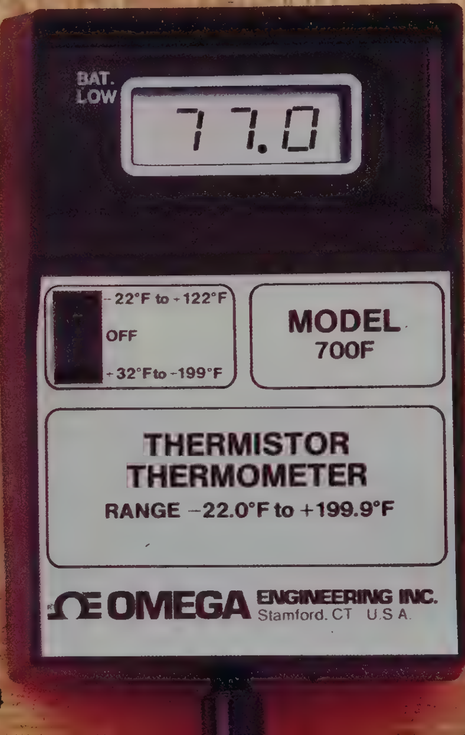
Models 700F and 700C are compatible with ALL OMEGA 700 Series Linear Response Thermistor Probes (see Pages F-13 and F-14). When ordering thermistor probes, add the suffix "PP" to the probe number and specify "with phone plug."

Probes for "700" Series Thermometers

Model 700 Hand Held Digital Thermometer is compatible with ALL OMEGA "700" Series Linear Response Thermistor Probes displayed on Pages F-13 and F-14. When ordering probes, add suffix "PP" to the probe number and specify "with phone plug."

Model 727 Digital Thermometer can be used with ANY OMEGA type K (Chromel-Alumel) Thermocouple. Some versatile thermocouple probes are shown in Sections A and D. When ordering thermocouples or probes, be sure to call out "with SMP-K-M connector" after the catalog number.

Model 737 Digital Thermometer is designed to give accurate measurement with ALL OMEGA Three-Wire 100 Ohm Platinum RTD Probes ($\alpha = 0.00385$) on Pages E-5 and E-6. When ordering probes, call out "with OTP-CU-M termination" after the catalog number.


BAT. LOW
77.0
-22°F to +122°F
OFF
+32°F to +199°F
MODEL 700F
THERMISTOR THERMOMETER
RANGE -22.0°F to +199.9°F
OMEGA ENGINEERING INC. Stamford, CT U.S.A.

Accessories

AC Adaptors
All 700 Series Hand Held Digital Thermometers have a receptacle built into the instrument which accepts this accessory. The AC adaptor allows the instrument to be powered from an alternating current source. Two models are available: Catalog No. ACD-110 for 110 VAC and Catalog No. ACD-220 for 220 VAC (supplied with DIN Standard European Plug).

Power	Catalog No.	Price
110 VAC, 60 Hz	ACD-110	$10
220 VAC, 50 Hz	ACD-220	$10

Soft Case
Vinyl-coated fabric instrument cases are available for Models 700, 727 and 737. Each case has a removable shoulder strap, as well as a spring clip for securing the case to a belt.

For Use with Model	Catalog No.	Price
700	SC700	$10
727	SC727	$10
737	SC737	$10

Rugged Carrying Cases
Rugged, high-impact plastic carrying cases are available for all 700 Series instruments. Each case is fitted with a resilient foam insert, which has recessed areas for the instrument, AC adaptor, as well as storage space for temperature probe(s). One universal case style will accept instrument Models 700, 727 and 737.

Catalog No.	Price
RCC-1000	$20

Replacement Batteries

	Price
For Model 727: Set of 6 Type "AA", Alkaline Catalog No. MN 1500-6	$3
For Models 700 and 737: One 9 volt, Catalog No. MN 1604	$3

Sensor Type	Model No.	Range(s)	Resolution	Accuracy	Price
700 Series Thermistor	700F	−22.0 to 122.0°F +32.0 to 199.9°F	0.1°F	±0.85°F*	$169
	700C	−30.0 to +50.0°C 0.0 to 100.0°C	0.1°C	±0.5°C*	
Type K (CH/AL) Thermocouple	727F	−50 to 999°F	1.0°F	±0.2% reading ±2°F	$149
	727C	−50 to 800°C	1.0°C	±0.2% reading ±2°C	
Platinum RTD 100 OHM $\alpha = 0.00385$	737CF	−148 to 1562°F	1.0°F	±0.2% reading ±1°F *or* °C	$179
		−100 to 850°C	1.0°C		

*Accuracy includes 700 Series probes (see Pages F-13 and F-14).

Additional Specifications

Operating Temperature Range:	0 to 40°C (32 to 104°F)
Storage Temperature Range:	−15 to 55°C (15 to 131°F)
Ambient Humidity:	85% R.H.
Cold Junction Compensation: (Model 727)	0.05°C/°C
Instrument Case Size:	5.4″L x 3.6″W x 1.9″H
Batteries: *Models 700 and 737:*	9 Volt Catalog No. MN 1604
Model 727:	6 Type "AA" Catalog No. MN 1500-6

Model 747 Differential Thermometer has precision 0.1°C or °F resolution for 700 Series Thermistors. This versatile two-probe thermometer has three measurement modes — Probe "A", Probe "B", Probe A *minus* Probe B (differential temperature).

The price is **$275.** See pages M-54 and M-55.

PROBES OPTIONAL

199.9
OMEGA
A
B
A-B
OFF
°C
°F

Noncontacting **NEW!**

Temperature Probe and Wyte Box™

Measure surfaces that are:

- Moving
- Too Delicate to Touch
- Electrically Hot
- Too Dangerous to Touch

OS-500

$360

Low Cost Infrared Measurements

Includes battery and 10 high emissivity target labels

- Read temperature with your multimeter or your recorder
- 1°C or 1°F equals 1 millivolt output
- Long life battery included
- Easily teamed with other instruments to make non-contacting and contacting measurement

OMEGA
OMEGA 880 DIGITAL MULTIMETER
188

The OMEGASCOPE™ OS-500 consists of hand held noncontact probe and electronics unit with integral cable.

OS-500
INFRARED TO mV CONVERTER
OMEGA

Model 880 Digital Thermometer $139

Not included with OS-500 but available with OS-500-880-kit.

OS-500
INFRARED TO mV CONVERTER
OMEGA
An OMEGA WYTE BOX™ PRODUCT

Noncontacting Temperature Probe and Wyte Box™

Low Cost Infrared Measurement Kits

OS-500
INFRARED TO mV CONVERTER
OMEGA

OS-500-881-KIT

$589 as shown

Rugged Carrying Case Included Free!

OS-500-STAND

$30

OS-500 Specifications:

Output:	1 mV/°F for OS-500F; 1 mV/°C for OS-500C
Temperature Range:	0 to 500°F or 0 to 260°C
Response Time:	1 second
Sensitivity:	1°F or 1°C
Accuracy:	± 1% of reading (plus or minus one digit)
Repeatability:	± ½% of reading (plus or minus one digit)
Minimum Target Size:	¼″ at ¾″
Target: Distance Ratio:	3:1 beyond ¾″ distance
Measurement Distance:	¼″ minimum
Spectrum:	8 to 14 microns
Power Source:	9 volt alkaline battery MN-1604
Probe:	1.25″ diameter × 6″ long weight: 4 ounces
Power Supply Unit:	2.5″ × 1.2″ × 4.5″ weight: 6 ounces

Off-the-Shelf Delivery!

How to Order

OS-500°F	Probe and Electronics with 1 mV/°F Output	**$360**
OS-500°C	Probe and Electronics with 1 mV/°C Output	
OS-500-881-KIT	Complete kit for non-contacting and contacting temperature measurement. Includes OS-500, OMEGA 881 Hand Held Digital Thermometer and Voltmeter, and Type K Probe and Cable. All in a RCC-1000 Rugged Case.	**$589**
OS-500-880-KIT	Complete kit for noncontacting measurement only. Includes OS-500 and the OMEGA 880 Hand Held Digital Thermometer in a RCC-1000 Rugged Case.	**$499**
SC-300	Optional soft case for carrying OS-500	**10**
OS-500-STAND	Universal position stand for OS-500	**30**
MN-1604	Replacement 9 volt alkaline battery	**3**

NEW! Infrared Pyrometer
Noncontact Surface Measurement
OMEGASCOPE™ 600

A Portable Stand Alone System!

- Optical Filter 8 to 14 microns to eliminate interference from ambient lighting and water vapor.
- Hand Held Sensing Head for easy use and accurate aiming.
- Easy-To-Read Display and electronics package. No other instruments are needed.
- Readout in °F or °C. Choose whichever scale you desire.
- Analog Output 1 mV/ degree to run a controller, a remote display or record measurements.

180
OS-600
INFRARED
THERMOMETER
EXTERNAL POWER (optional)
F
C
ON
OFF
OUTPUT
1 mV/°C or °F
OMEGA
ENGINEERING, INC.

For Surfaces That Are:

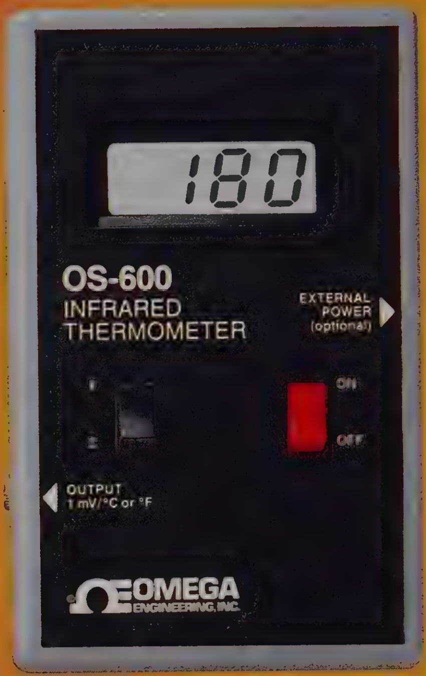
- Too delicate to touch
- Moving
- Too dangerous to touch
- Hard to reach

Model OS-600

$490 Complete with sensing head, electronics and display

Infrared Pyrometer NEW!
Noncontact Surface Measurement
OMEGASCOPE™ 600

A Portable Stand Alone System!



Specifications:

Temperature Range: 0 to 500°F
0 to 260°C
Resolution: 1°F or 1°C
Accuracy: ±(1% rdg + 1 digit)
Repeatability: ±(½% rdg + 1 digit)
Target Size: ¼" min at ½" distance
Target Ratio: 1:3 (target to distance)
Analog Output: 1 mV per deg (C or F)
Power: 9 V alkaline battery or 110 V ac
Battery Life: 200 hours, min
Probe Size: 1.25" diameter x 6" long
Display Size: 3.5" x 1.3" x 5.7"
Weight, Probe: 4 oz.
Display: 6 oz.
Filter: 8 to 14 microns

Model OS-600
$490

How to Order *In Stock for Immediate Delivery*

OS-600	Self-contained Infrared Sensor and Display, including battery	**$490**
OS-500-Stand	Universal Position Stand	**30**
OS-600-Kit	OS-600 plus OS-500-Stand in a rugged case	**540**
SC-300	Soft carrying case	**10**
MN-1604	Replacement 9 V alkaline battery	**3**

Complete Kit
OS-600-Kit
$540

Everything you need for infrared measurements!

Contains: OS-600 (sensing head and display) plus OS-500-Stand. Packaged in a rugged, shock resistant carrying case.

Precision Infrared Pyrometer Kit

Noncontact Surface Thermometer

High Performance Features

- 50°C to 700°C
- 3/16" Spot Size at 5¼"
- Adjustable Emissivity
- Analog Output 1 mV/°C to Run Recorder or Controller
- Display Peak or Last Temp.
- Calibrate Emissivity with a Type K Thermocouple

Now—Measure Temperature on Difficult Surfaces that are:

- Moving
- Electrically Hot
- Fragile
- Freshly Painted
- Hard to Reach
- Rough, Uneven
- Chemically Active

Pyrometer
NiCr-Ni DIN Type K
199
OMEGA

Rugged Mountable Detector Head

$1400

OS-760-KIT

Complete Kit as Shown

Positioning Gage Ensures Accurate Infrared Measurements

Surface Probe Included!

Additional Hand Held Thermocouple Probes in Section D

Thermocouple Adaptor Included

Precision Infrared Pyrometer Kit

Carrying Case Included

Kit Includes:

- Detector Head
- Hand Held Readout
- Type K (Chromel-Alumel) Surface Probe
- Quick Disconnect Handle
- Positioning Gage
- Rugged Carrying Case

$1400

Complete Kit as Shown

TWO INPUTS: Type K Thermocouple or Infrared. Will accept any OMEGA type K Thermocouple with an SMP Connector, see Section D.

Specifications:

Temp. Range	50°C to 700°C
Resolution:	1°C
Accuracy, Meter:	±2°C from 0° to 200°C ±1½% ± 1 digit over 200°C
IR Head:	1½% of measurement
Spot Size/Distance:	1:3 beyond 2 feet
Min. Spot Size:	5⅙″ at 5¼″
Emissivity:	.4 to 1.0
Repeatability:	+1%
Ambient Temperature:	0°C to 40°C (22°C optimum)
Storage:	−30°C to +60°C
Coefficient:	.004%/°C ± .008°C/°C of measurement
Update Rate:	2/second
Response Time, IR Head:	100 milliseconds
Display:	½ inch LCD
Spectrum:	0.4 to 30 microns
Weight, Case:	11 ounces
IR Sensor:	16 ounces

How to Order:

Part No.	Description	Price
OS-760-KIT	Meter, with IR radiation sensor and 5 foot cable, type K probe and handle, SMP adaptor, 5 foot analog output cable with banana plugs, service case, and a 9 V alkaline battery	**$1400**
Replacement Parts:		
MN-1604	Spare 9 V alkaline battery	**$3**
OS-760-FILM	Replacement optics film, 2 sheets, 8½″ × 11″	**12**
OS-760-ADAPT-110V	110 V ac adaptor/recharger for optional NiCad battery	**20**
OS-760-ADAPT-220V	220 V ac adaptor/recharger for optional NiCad battery	**20**
OS-760-GC9	Optional 9 V NiCad battery	**10**

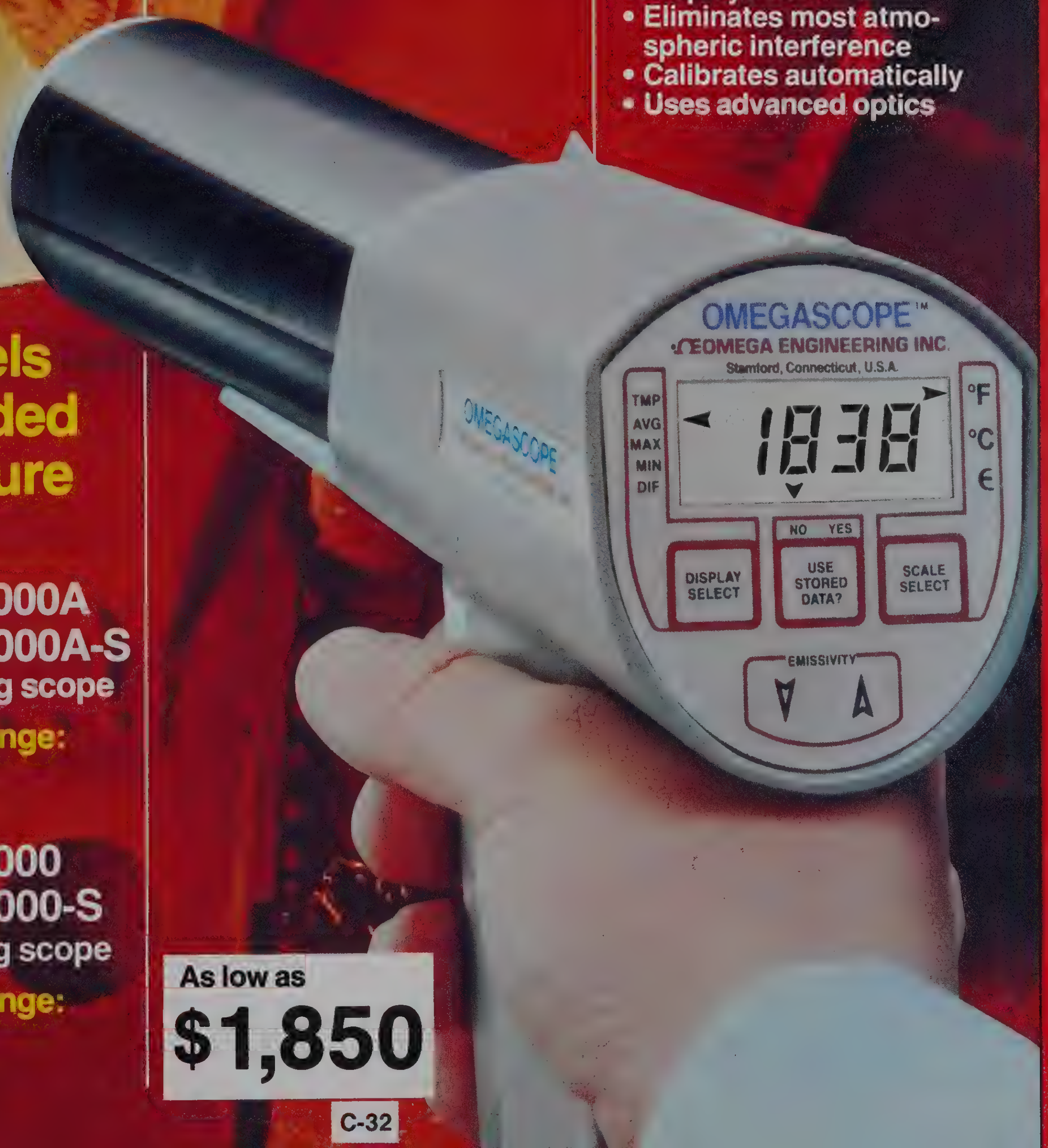
Choose OMEGALINE™ 600 or other recorders in Section N. See many process controllers in Section P.

Infrared Pyrometers

At Last–The Computerized OMEGASCOPE™

Measures Temperature at a Distance

- Calculates temperature minimum, maximum, difference, and average
- Displays single readings.
- Displays °C or °F
- Eliminates most atmospheric interference
- Calibrates automatically
- Uses advanced optics


OMEGASCOPE
OMEGASCOPE™
ΩOMEGA ENGINEERING INC.
Stamford, Connecticut, U.S.A.
TMP
AVG
MAX
MIN
DIF
1838
°F
°C
ε
NO YES
DISPLAY SELECT
USE STORED DATA?
SCALE SELECT
EMISSIVITY

Two Models for Extended Temperature Range

Model OS-2000A
OS-2000A-S
with sighting scope

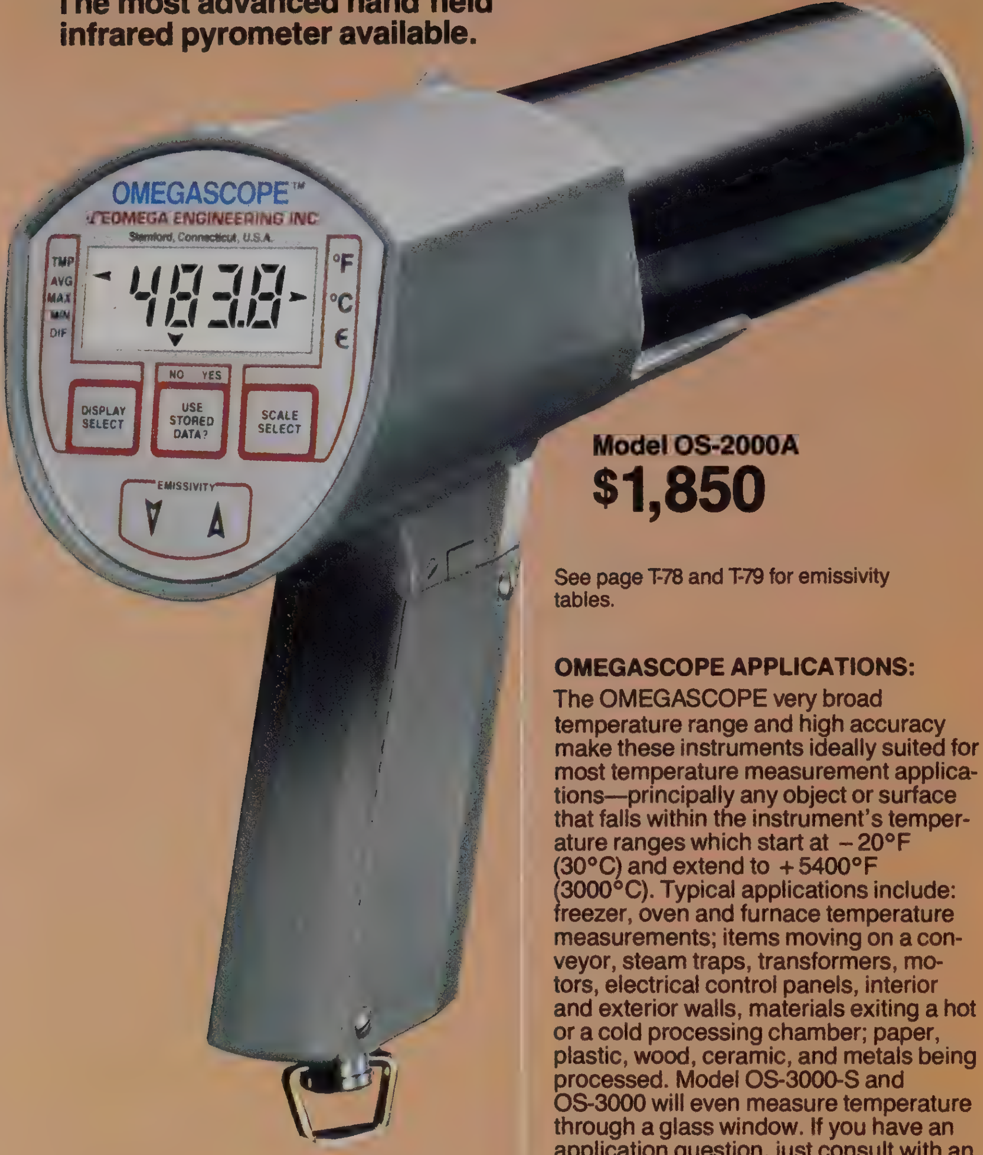
Temperature Range:
– 20° to 2500°F
– 30° to 1400°C

Model OS-3000
OS-3000-S
with sighting scope

Temperature Range:
750° to 5400°F
400° to 3000°C

As low as
$1,850

The most advanced hand held infrared pyrometer available.


OMEGASCOPE™
OMEGA ENGINEERING INC
Stamford, Connecticut, U.S.A.
TMP
AVG
MAX
MIN
DIF
4838
°F
°C
ε
NO YES
DISPLAY SELECT
USE STORED DATA?
SCALE SELECT
EMISSIVITY

Model OS-2000A

$1,850

AT LAST—THE OMEGASCOPE™:

Accurate, broad-ranged, infrared pyrometer with the calculating ability to satisfy 90 percent of today's users! Making this possible is the OMEGASCOPE powerful microprocessor which commands and manipulates the incoming sensor information, resulting in high accuracy over two broad temperature ranges: −20°F to +2500°F (−30°C to +1400°C) and +750°F to +5400°F (+400°C to 3000°C)—an accomplishment never before achieved with infrared pyrometers.

Simply press the trigger and the OMEGASCOPE microprocessor instructs the advanced sensor circuitry to automatically calibrate in less than two seconds. The powerful, eight-bit microprocessor then determines the proper electronic gain, linearizes the sensor, scales, and makes the °C to °F conversion four times a second. And, that's not all. The comprehensive computer program in the OMEGASCOPE also stores the readings so the OMEGASCOPE can be interrogated later to calculate temperature average, maximum, minimum and difference between the maximum and minimum values. As many as 64,000 temperature readings can be used for the temperature calculations.

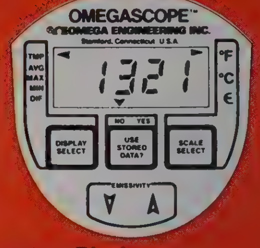
See page T-78 and T-79 for emissivity tables.

OMEGASCOPE APPLICATIONS:

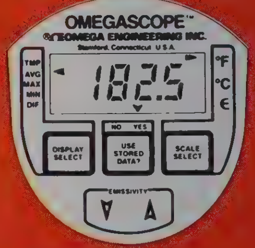
The OMEGASCOPE very broad temperature range and high accuracy make these instruments ideally suited for most temperature measurement applications—principally any object or surface that falls within the instrument's temperature ranges which start at −20°F (30°C) and extend to +5400°F (3000°C). Typical applications include: freezer, oven and furnace temperature measurements; items moving on a conveyor, steam traps, transformers, motors, electrical control panels, interior and exterior walls, materials exiting a hot or a cold processing chamber; paper, plastic, wood, ceramic, and metals being processed. Model OS-3000-S and OS-3000 will even measure temperature through a glass window. If you have an application question, just consult with an OMEGA Applications Engineer.

HOW THE OMEGASCOPE WORKS:

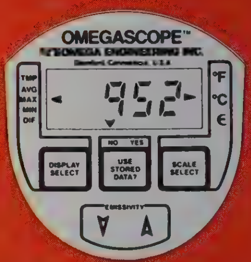
- It's easy!—Simply aim the OMEGASCOPE at the target, pull and hold the trigger. It will self-calibrate, calculate and display the object's temperature four times a second.
- **Measures from any distance**–From two feet to hundreds of feet, OMEGASCOPE will accurately measure any target larger than the unit's field of view.
- **Digital readout**–Four-digit LCD display eliminates reading errors and speeds comparisons.
- **OMEGASCOPE** five modes of operation—The OMEGASCOPE measures temperature, computes average temperature, stores maximum and minimum values and calculates the difference between them.
- **Automatic data storage**–Regardless of which of five modes is selected, the OMEGASCOPE stores and does the five calculations simultaneously. Until new measurements are taken, these calculations are held in memory for instant recall.
- **Computations**–OMEGASCOPE can use the automatically stored temperature data to compute the running average, maximum, minimum, and temperature difference of several objects or a single object. Each time the trigger is pulled new measurements are added and compared to the previously stored data. By using a sophisticated computer program, up to 64,000 measurements can be accumulated and processed.
- **Fahrenheit and Celsius** readings—Keyboard areas on display select the temperature scale. For maximum flexibility, measurement data from memory is available in degrees F or degrees C, regardless of how it was measured.


OMEGASCOPE™
OMEGA ENGINEERING INC.
Stamford, Connecticut U.S.A.
TMP
AVG
MAX
MIN
DIF
1321
°F
°C
ε
NO YES
DISPLAY SELECT
USE STORED DATA?
SCALE SELECT
EMISSIVITY

Temperature Display:
Updated four times each second. The display pointer flashes while new measurements are being made.


OMEGASCOPE™
OMEGA ENGINEERING INC.
Stamford, Connecticut U.S.A.
TMP
AVG
MAX
MIN
DIF
182.5
°F
°C
ε
NO YES
DISPLAY SELECT
USE STORED DATA?
SCALE SELECT
EMISSIVITY

Average Temperature:
Set USE STORED DATA? to YES and calculate average temperature of several different objects.


OMEGASCOPE™
OMEGA ENGINEERING INC.
Stamford, Connecticut U.S.A.
TMP
AVG
MAX
MIN
DIF
952
°F
°C
ε
NO YES
DISPLAY SELECT
USE STORED DATA?
SCALE SELECT
EMISSIVITY

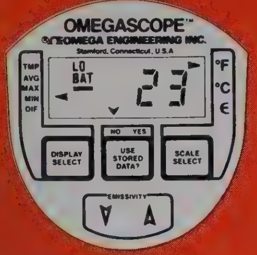
Maximum Temperature:
Calculates and stores highest temperature spotted since trigger was pulled.

ACCESSORIES

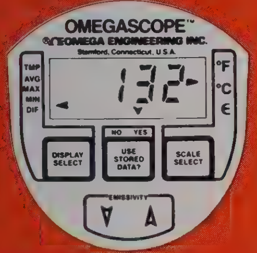
(Description on page C-37)

BB-2
Heated Blackbody

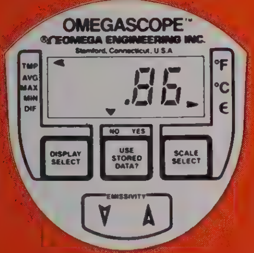
BB-1
Blackbody Plate


OMEGASCOPE™
OMEGA ENGINEERING INC.
Stamford, Connecticut, U.S.A.
TMP
AVG
MAX
MIN
DIF
LO BAT
23
°F
°C
ε
NO YES
DISPLAY SELECT
USE STORED DATA?
SCALE SELECT
EMISSIVITY

Lowest Temperature:
Calculates the lowest temperature automatically while scanning the object. LO BAT indicates when battery should be replaced.


OMEGASCOPE™
OMEGA ENGINEERING INC.
Stamford, Connecticut, U.S.A.
TMP
AVG
MAX
MIN
DIF
132
°F
°C
ε
NO YES
DISPLAY SELECT
USE STORED DATA?
SCALE SELECT
EMISSIVITY

Temperature Difference:
Set USE STORED DATA? to YES, aim at one object, pull trigger, aim at second object, pull trigger to display largest difference.


OMEGASCOPE™
OMEGA ENGINEERING INC.
Stamford, Connecticut, U.S.A.
TMP
AVG
MAX
MIN
DIF
.86
°F
°C
ε
NO YES
DISPLAY SELECT
USE STORED DATA?
SCALE SELECT
EMISSIVITY

Emissivity Adjustment:
Match target emissivity to nearest one hundredth.

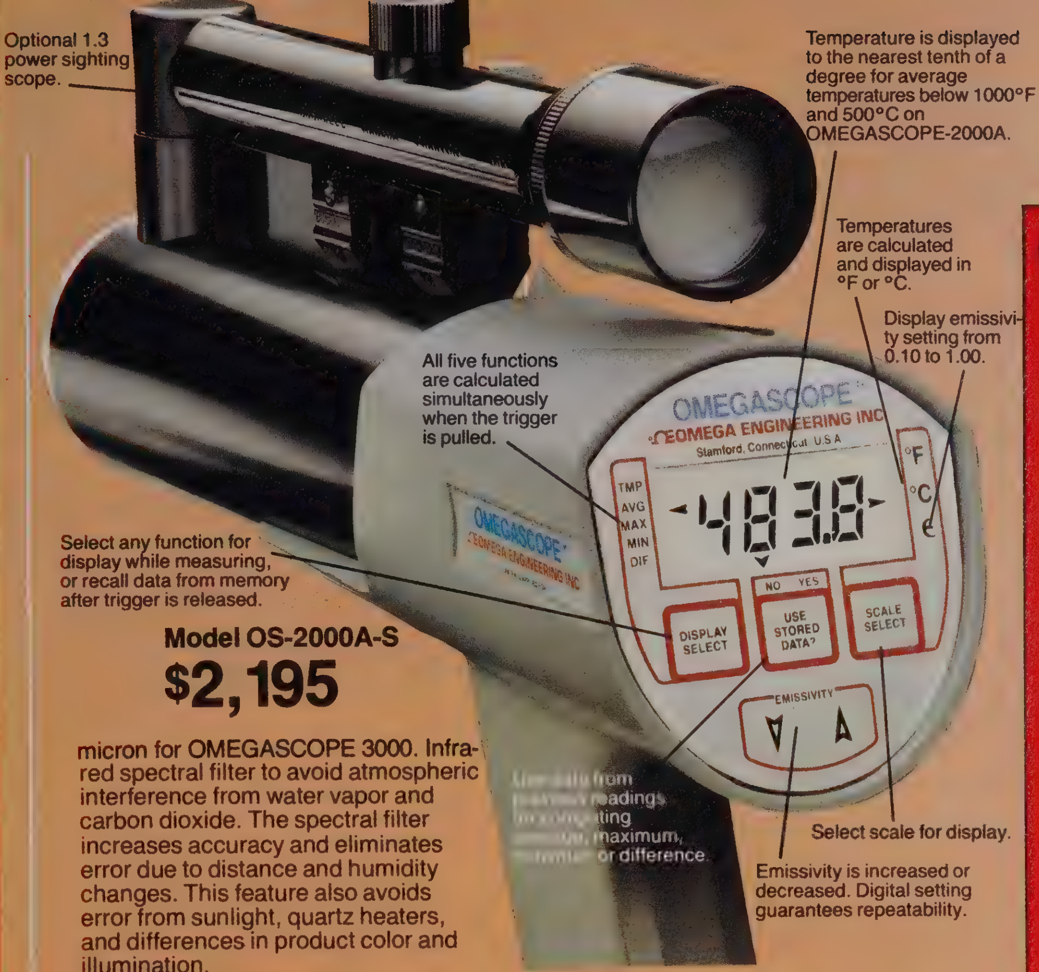
RCC-2000 and RCC-3000

Rugged Carrying Cases

ADDITIONAL FEATURES:

Each OMEGASCOPE offers the user the following important features at no additional cost—features that are only economically feasible in instruments of this size and price by using a sophisticated microprocessor, and advanced optics and signal conditioning.

- **Emissivity Adjustment**—Set emissivity digitally through the custom keyboard and guarantee perfect repeatability every time.
- **Special Filtering**—8 to 14 micron for OMEGASCOPE 2000A or 2.1 to 2.3 micron for OMEGASCOPE 3000. Infrared spectral filter to avoid atmospheric interference from water vapor and carbon dioxide. The spectral filter increases accuracy and eliminates error due to distance and humidity changes. This feature also avoids error from sunlight, quartz heaters, and differences in product color and illumination.
- **Increased Resolution**—For temperatures less than 1000°F and 500°C the OMEGASCOPE 2000A calculates the average temperature to the nearest 0.1 degree for the most precise comparisons.
- **Self-Calibration**—Automatically calibrates prior to each measurement and checks its own functions.
- **Low Battery Warning**—Automatic display indicates when battery changing is necessary.
- **Automatic Power-Off**—When the trigger is released, OMEGASCOPE shuts off power immediately to all functions except memory and display to avoid unnecessary battery drain. Manual switch disconnects power for lengthy storage.
- **Rugged Housing**—OMEGASCOPE aluminum housing is lightweight, yet rugged to provide reliable performance in varying industrial environments.


OMEGASCOPE™
OMEGA ENGINEERING INC
Stamford, Connecticut U.S.A
TMP
AVG
MAX
MIN
DIF
483.8
°F
°C
ε
NO YES
DISPLAY SELECT
USE STORED DATA?
SCALE SELECT
EMISSIVITY
OMEGASCOPE™
OMEGA ENGINEERING INC

Optional 1.3 power sighting scope.

Temperature is displayed to the nearest tenth of a degree for average temperatures below 1000°F and 500°C on OMEGASCOPE-2000A.

Temperatures are calculated and displayed in °F or °C.

Display emissivity setting from 0.10 to 1.00.

All five functions are calculated simultaneously when the trigger is pulled.

Select any function for display while measuring, or recall data from memory after trigger is released.

Uses data from previous readings in computing average, maximum, minimum or difference.

Select scale for display.

Emissivity is increased or decreased. Digital setting guarantees repeatability.

Model OS-2000A-S

$2,195

MAXIMUM VALUE:

The OMEGASCOPES, with their simple custom keyboard operation, digital readout, computerized accuracy, and other exclusive features are essential tools where fast, precise temperature measurement is a critical factor. Wide temperature range and simultaneous microsecond calculations will improve production and process control, conserve energy and spot equipment failures before they cause costly downtime.

For spot-checking temperatures on your production line, for preventative maintenance in your operation, or for inspecting plant equipment, the OMEGASCOPE gives you temperature measurement rapidly and accurately. You can count on them every time. Every OMEGASCOPE is backed by the OMEGA standard 12-month warranty and is supplied with a Certificate of Calibration.

OMEGASCOPE
OMEGA ENGINEERING INC.

Model OS-3000-S with Scope

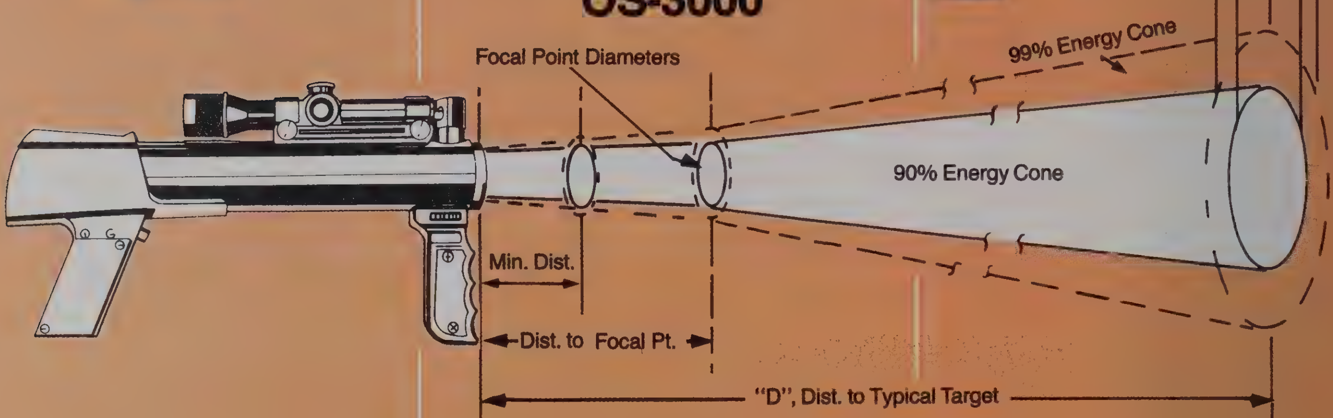
$2,395 As Shown

Infrared Pyrometers
OMEGASCOPE™ 3000

Model OS-3000-S
$2,395

with sighting scope and carrying case

Field of View OS-3000


Typical Target Diameters
Focal Point Diameters
99% Energy Cone
90% Energy Cone
Min. Dist.
Dist. to Focal Pt.
"D", Dist. to Typical Target

	Min. Target Distance		Focal Point		Target Size
	Distance	Target Dia.	Distance	Target Dia.	Beyond Focal Point
90% energy cone	36"	.58"	78"	.67"	Targeted Dist/120
99% energy cone	36"	.92"	78"	1.34"	Targeted Dist/60

Specifications

Temperature Range:	750°F to 5400°F (400°C to 3000°C)
Accuracy*: (NBS Traceable)	± 1% of reading ± 1°C or °F
Emissivity:	0.10 to 1.0 in 0.01 steps.
Filter:	2.1 to 2.3 microns
Operating Temperature:	32°F to 120°F (0°C to 50°C)
Storage Temperature:	−40°F to 150°F (−40°C to 65°C)
Battery:	9 V alkaline, supplied with each instrument
Battery Life:	8 hours, typically 5000 uses. 3 months if simply maintaining memory and display

* Under standardized conditions: 1) instrument temperature well stabilized and within operating ambient range, 2) target emissivity is 1.0, 3) target fills 99% energy cone, 4) target distance is 36" minimum.

Dimensions

Length:	15.0" (381 mm)
Height:	6.5" (165 mm)
Width:	3.0" (76 mm)
Weight:	3.2" lbs. (1.5 kg)
With Scope:	3.7" lbs. (1.7 kg)

Model OS-3000
$2,095

OMEGASCOPE™ 2000A

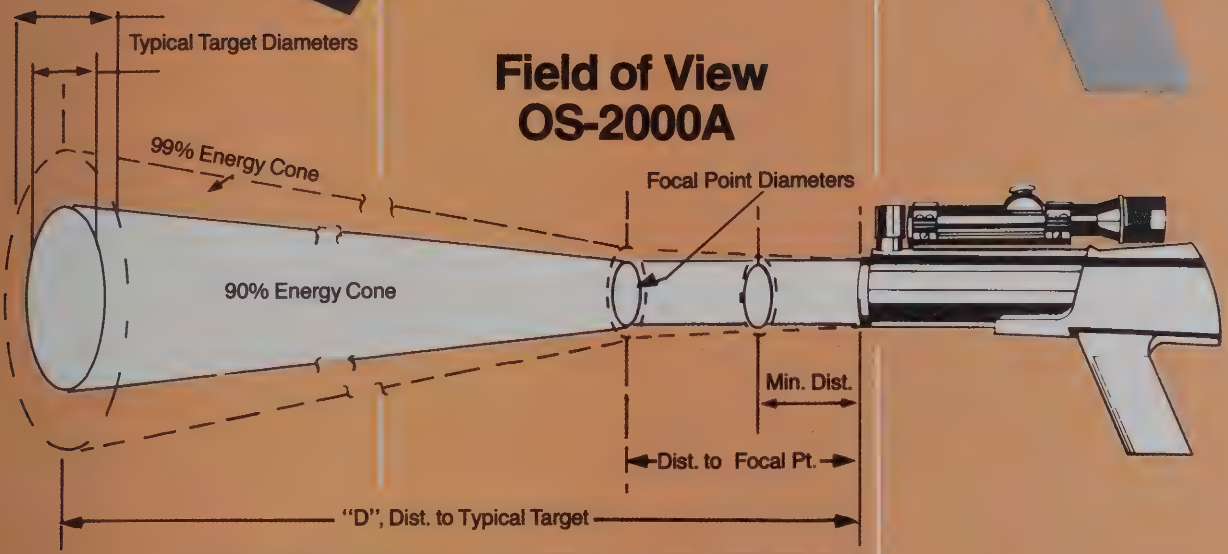
Model OS-2000A-S
$2,195

with sighting scope and carrying case

OMEGASCOPE
OMEGA ENGINEERING INC.

BB-2
Heated
Blackbody
with Stand

Field of View
OS-2000A


Typical Target Diameters
99% Energy Cone
90% Energy Cone
Focal Point Diameters
Min. Dist.
Dist. to Focal Pt.
"D", Dist. to Typical Target

	Min. Target Distance		Focal Point		Target Size
	Distance	Target Dia.	Distance	Target Dia.	Beyond Focal Point
90% energy cone	18"	1.68"	39"	1.30"	Target Dist/30
99% energy cone	18"	2.28"	39"	2.60"	Target Dist/15

Specifications

Temperature Range:	−20°F to 2500°F (−30°C to 1400°C)
Accuracy*: (NBS Traceable)	Above 100°F (38°C) ± 1% of rdg. ± 1° Below 100°F (38°C) ± 1.5% of rdg. ± 1°
Emissivity:	0.10 to 1.0 in 0.01 steps
Filter:	8 to 14 microns
Operating Temperature:	32°F to 120°F (0°C to 50°C)
Storage Temperature:	−40°F to 150°F (−40°C to 65°C)
Battery:	9 V alkaline, supplied with each instrument
Battery Life:	8 hours, typically to 5000 uses. 3 months if simply maintaining memory and display

* Under standardized conditions: 1) instrument temperature well stabilized and within operating ambient range, 2) target emissivity is 1.0, 3) target fills 99% energy cone, 4) target distance is 24", minimum.

Dimensions

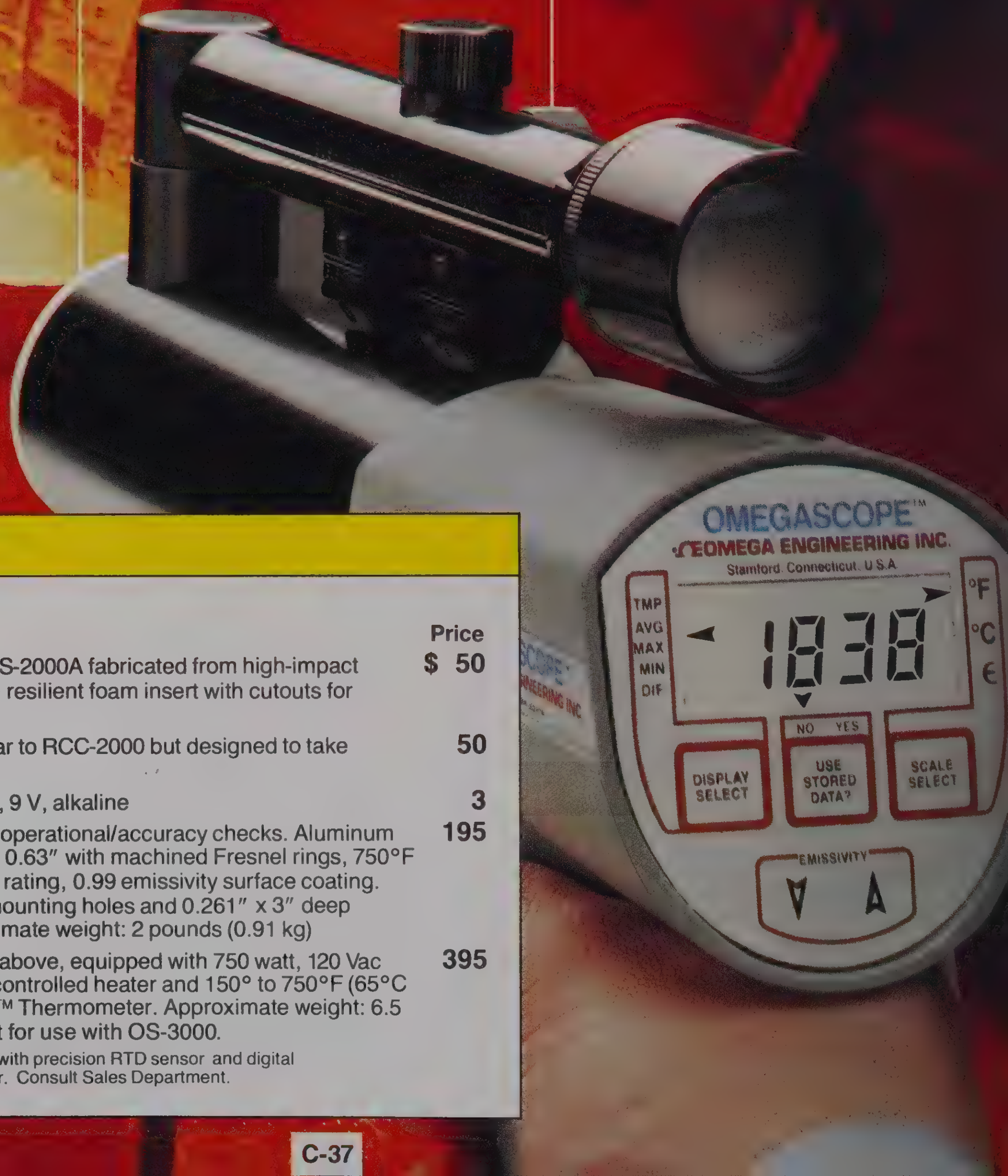
Length:	10.0" (254 mm)
Height:	6.5" (165 mm)
Width:	3.0" (76 mm)
Weight:	2.0 lbs. (0.9 kg)
With Scope:	2.9 lbs. (1.3 kg)

Model OS-2000A
$1,850

Infrared Pyrometers

How To Order

Catalog Number	Description	Price
OS-2000A	Optical pyrometer covering –20°F to 2500°F (–30°C to 1400°C) temperature range. Includes 9 V alkaline battery.	$1,850
OS-2000A-S	Same as OS-2000A, plus unit is fitted with 1.3 power sighting scope with binocular prism viewing through axis of barrel. Includes 9 V alkaline battery and RCC-2000 carrying case.	2,195
OS-3000	Optical pyrometer covering 750°F to 5400°F (400°C to 3000°C) temperature range. Includes 9 V alkaline battery.	2,050
OS-3000-S	Same as OS-3000, plus unit is fitted with 1.3 power sighting scope with binocular prism viewing through axis of barrel. Includes 9 V alkaline battery and RCC-3000 carrying case.	2,395



Accessories

Catalog Number	Description	Price
RCC-2000	Carrying Case: For OS-2000A fabricated from high-impact plastic and fitted with resilient foam insert with cutouts for instrument.	$ 50
RCC-3000	Carrying Case: Similar to RCC-2000 but designed to take OS-3000	50
MN-1604	Replacement battery, 9 V, alkaline	3
BB-1	Black body target for operational/accuracy checks. Aluminum plate 6.25″ x 6.25″ x 0.63″ with machined Fresnel rings, 750°F (398°C) temperature rating, 0.99 emissivity surface coating. Equipped with four mounting holes and 0.261″ x 3″ deep sensor hole. Approximate weight: 2 pounds (0.91 kg)	195
BB-2	Black body target as above, equipped with 750 watt, 120 Vac variable thermostat controlled heater and 150° to 750°F (65°C to 398°C) Dial Temp™ Thermometer. Approximate weight: 6.5 pounds. (2.9 kg). Not for use with OS-3000.	395

NOTE: BB-1 and BB-2 can be supplied with precision RTD sensor and digital instrumentation on special order. Consult Sales Department.

NEW!

OMEGASCOPE™ II

For Noncontact Temperature Measurement

A Field Installable Microprocessor Based Infrared Thermometer System

1000.
°C
°F
OMEGASCOPE™ II
OMEGA
ENGINEERING, INC.
STAMFORD CONN

$1495

complete OS-1000 as shown.

OMEGASCOPE™ II A Field Installable Infrared Thermometer System

OMEGASCOPE™II. The first microprocessor based thermometer system designed to operate in extreme environments, and flexible enough for use in process control. The OMEGASCOPE II system can be used as a temperature measurement and display unit, and it has the added capability of either linearized voltage or current, or type J thermocouple outputs for use with temperature controllers. OMEGASCOPE II can increase quality, energy savings and reduce waste, all because of the advanced combination of infrared temperature sensing and microprocessor control.

MICROPROCESSOR FLEXIBILITY. The advanced design of OMEGASCOPE II results in high accuracy and precise outputs, as well as a self-test capability, and standard temperature equivalents for control system calibration. The microprocessor design also provides wide temperature ranges, switch selection of °F or °C units, and selectable thermocouple, current, or voltage outputs. All functions are fully digital to assure the highest reliability and accuracy for both measurement and control applications.

WIDE TEMPERATURE RANGE. OMEGASCOPE II systems are capable of temperature measurements up to 1350°F (748°C). In addition, within the overall temperature range, one of twenty switch selectable subranges can be chosen to match a controller input or recording device, and to provide increased sensitivity over the selected narrow temperature subrange.

DIGITAL DISPLAY. The four digit LED display normally indicates measurement temperature. During system setup, the display shows actual current output, calibration output, or percent peak hold. The display also indicates the sensing head temperature, and if the measurement temperature exceeds the limits of the selected temperature range.

DIGITAL PEAK HOLD. This feature of OMEGASCOPE II is fully adjustable from no hold to infinite hold. This allows measurements of moving objects, objects that are periodically blocked, or widely varying object temperatures. The hold can be reset easily, using an external contact closure.

DIGITAL EMISSIVITY. Emissivity, a measure of the effectiveness of surface radiation, can be adjusted from 0.10 to 0.99 to assure precise, repeatable, accurate measurements.

SELF-TEST. OMEGASCOPE II can be self-tested to help isolate problems between the sensing head and the main unit. Also, the internal temperature of the sensing head can be displayed to ensure that the sensing head is operated within its temperature limits.

SYSTEM CALIBRATION AND SETUP. OMEGASCOPE II provides four calibrated thermocouple equivalent outputs and precise current outputs for system calibration. With these outputs, OMEGASCOPE II can be used to set up recorders or controllers, or to isolate problems within the system.

RUGGED. OMEGASCOPE II is designed as a rugged thermometer for industrial use, and comes complete with a sensing head, integral 25 ft. cable, and the display/control main unit mounted in a dust, oil, and moisture resistant NEMA 12 enclosure. All accessories, including the sealed sensing head, are hard anodized aluminum, which reduces susceptibility to corrosion. Since there are no moving parts, the standard sensing head can be installed in severe environments with temperatures up to 150°F (65°C).

OPTIONAL ACCESSORIES. A Water Cooled Shell allows placement of the sensing head in ambient temperatures of up to 350°F (175°C). An Air Purge Collar fits directly onto either the Standard or the Water Cooled Sensing Head to protect the optics against airborne contaminants. Other optional accessories include a Mounting Flange, a Fixed Mounting Bracket, and an adaptor to allow installation of armored cable to the sensing head for complete mechanical protection. All sensing heads and accessories utilize the same 1½" x 20 thread which allows the fittings to be assembled in any sequence. The special design of the sensing head results in a sealed internal module that rotates within its housing to prevent cable twisting during assembly.

CONTROL AND RECORDING OUTPUTS. OMEGASCOPE II can be used with almost any recorder or controller, just by switch selecting either a thermocouple equivalent, current, or voltage output.

Thermocouple

OMEGASCOPE II can be used as a "noncontact" thermocouple probe. By using Type J (Iron/Constantan) thermocouple wire as a connection between the output of the OMEGASCOPE II and any thermocouple recorder, indicator or control system input, OMEGASCOPE II acts as a thermocouple sensor, resulting in increased accuracy in both monitoring and control applications.

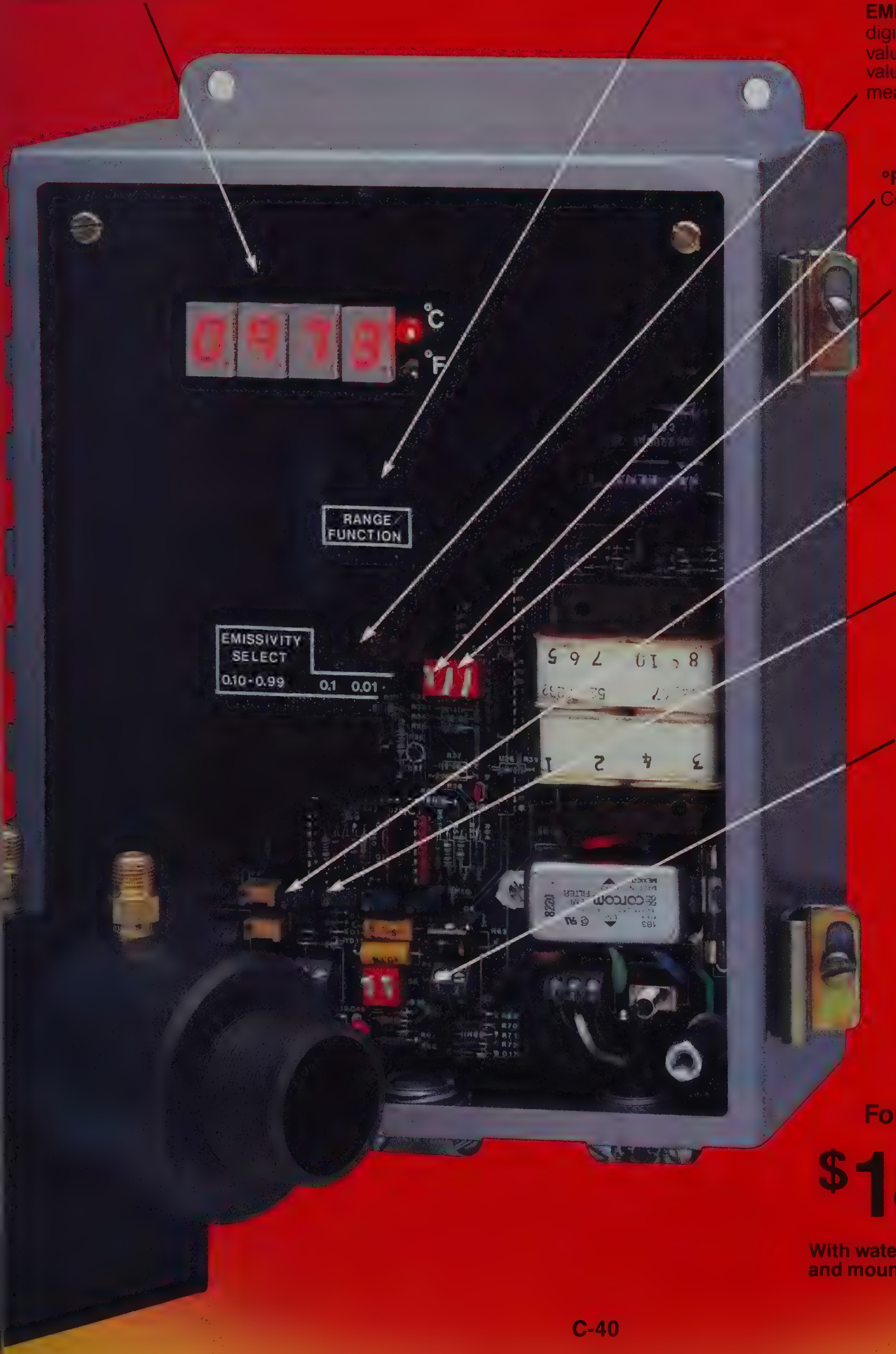
Current

Any device which accepts standard milliamp input (i.e., 0 to 5 mA, 4 to 20 mA, 10 to 50 mA, etc.) can be connected to OMEGASCOPE II. This output can be used with meters, controllers and other devices which accept current input. OMEGASCOPE II can also be individually tailored for output limits.

Voltage

Proper selection of a load resistor across the current output provides selectable output voltage ranges up to 10 volts full scale. This variety allows OMEGASCOPE II to match practically any recording or control device input range.

Standard Features



DIGITAL DISPLAY shows temperatures in °F or °C, precise test values, or actual output current limits. Values can be reset to duplicate previous measurement conditions.

RANGE/FUNCTION Used to select any of 20 standard temperature ranges. This switch also allows selection of standard values to calibrate or troubleshoot a measurement/control system.

EMISSIVITY SELECT Allows digital setting of known emissivity values or resetting of previous values for accurate, repeatable measurements.

°F/°C Selects Fahrenheit or Celsius display.

LIN/J Selects either linear current or type J thermocouple output.

mA ADJUST Allows adjustment of LOW (0 to 10 mA) and HIGH Current (5 to 50 mA). Actual output current limits are displayed to the nearest 0.1 mA.

PEAK HOLD ADJUST allows setting of desired hold value on the digital display.

PEAK HOLD RESET allows remote reset of hold function.

NEMA 12 ENCLOSURE Rugged oil and moisture sealed metal case.

For Severe Environments

$1820

With water cooled sensor, air purge collar and mounting bracket.

OMEGASCOPE™ II A Field Installable Infrared Thermometer System

1000.
°C
°F
OMEGASCOPE™ II
OMEGA
ENGINEERING, INC.
STAMFORD, CONN

$1495
complete OS-1000 as shown.

Sensing Heads and Accessories

Mounting Flange

Used to mount the sensing head. 4.75″ (121 mm) diameter × 0.25″ (6.4 mm) thick. Three 0.266″ (6.8 mm) holes on a 4″ (102 mm) diameter pattern.

OS-1000-02 **$25**

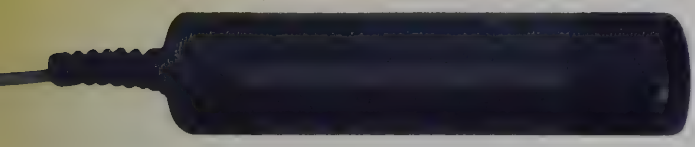
Air Purge Collar

Used to prevent accumulation of airborne contaminants on the lens. 2.5″ (63.5 mm) diameter × 3.0″ (76.2 mm) long. 1/8″ NPT air fittings supplied.

OS-1000-27 **$75**

Standard Sensing Head

Complete with 25 feet (7.6 meter) integral cable. 1.5″ (38 mm) diameter × 6.25″ (159 mm) long. (Included with main unit).



Conduit Adaptor

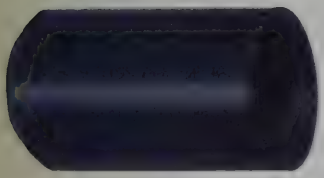
Used on the rear of the sensing head to adapt sensing head cable to electrical conduit fittings for complete mechanical protection of sensing head cable. 2.0″ (51 mm) diameter × 3.25″ (82.6 mm) long.

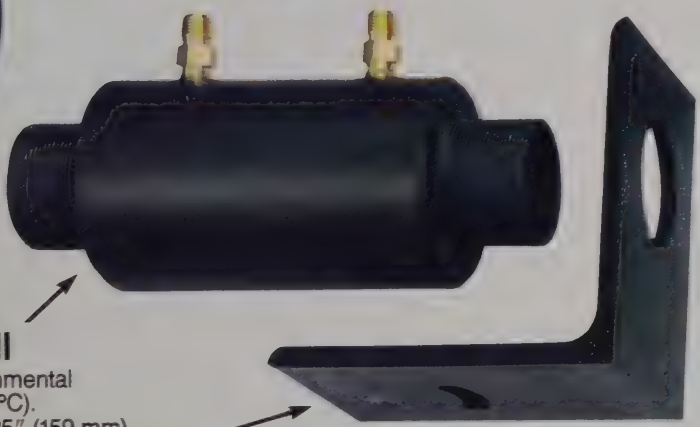
OS-1000-35 **$60**

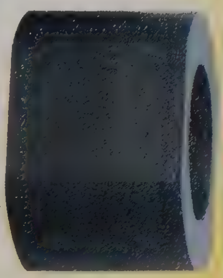
Mounting Nuts

Used to mount the sensing head. May also be used as a lock nut when used with the MOUNTING FLANGE or FIXED BRACKET. 2.0″ (51 mm) hexagon × 0.31″ (7.9 mm) thick.

OS-1000-93 **$15**







Water Cooled Shell

Used for sensing head environmental temperatures up to 350°F (175°C). 2.5″ (63.5 mm) diameter × 6.25″ (159 mm) long. 1/8″ NPT fittings supplied.

OS-1000-11 **$225**

Fixed Bracket

Used to mount the sensing head in a rigid, permanent position. Bracket is threaded to accept 1½″ × 20 sensing head threads. 4″ (102 mm) high × 4″ (102 mm) long × 3″ (76 mm) wide.

OS-1000-38 **$25**

Pipe Adaptor

Used to mount the sensing head when using a 1½″ NPT iron pipe sight tube. 2.5″ (63.5 mm) diameter × 2.0″ (51 mm) long. **OS-1000-92** **$50**

OMEGASCOPE II is a complete, noncontact measurement system, including a rugged sealed sensing head with an integral 25 ft. (7.6m) cable and a display/control main unit mounted in a NEMA 12 enclosure.

Standard features include:

- **Wide Temperature Range**
  - —switch select °F or °C
  - —20 selectable subranges
- **Flexible Outputs**
  - —thermocouple equivalent
  - —current
  - —voltage
- **Digital Temperature Display**
- **Digital Emissivity Setting**
- **Digital Adjustable Peak Hold**
- **Self-Test**
- **Calibration Outputs**
- **Instant-on Electronics**

OMEGASCOPE™ II A Field Installable Infrared Thermometer System

NEW MODELS AVAILABLE!

OS-1000-CSS for close measurements to 2¾″.
OS-1000-HT for high temperature measurements up to 5400°F!

Consult Sales Department for Details.

Specifications

Temperature Ranges (User Selectable) All ranges standard

°F	°C	°F	°C
0—1350	0—748	100— 600	60—300
0— 100	0— 50	200—1000	100—500
0— 200	0—100	0—1000	0—500
80— 400	40—200	400—1000	200—500
100— 500	50—250	400—1300	200—748

Accuracy:

Target Temperature Greater Than 99°F (38°C): ±(1% reading + 1 digit) at head ambient of 77°F (25°C)

Target Temperature Less Than 100°F (37°C): ±(2% reading + 1 digit) at head ambient of 77°F (25°C)

Sensing Head Temperature Coefficient: ±0.09% per °F (±0.05% per °C) deviation from 77°F (25°C)

Head Interchangeability: 1% maximum

Warm Up Time: Less than 10 seconds for rated accuracy

Optics:

Spectral Response: 8-14 microns

Field of View: 11 : 1 (4°), 90% energy
Minimum Spot Size: 1″ (25.4 mm) at 11″ (280 mm)

Display:

Resolution: 1°F or 1°C

Modes: Temperature °F or °C, output current, % peak hold, system diagnostics, sensing head temperature

Reading Rate: Two per second

Output: Selectable. Either type J (iron/constantan) thermocouple, current (adjustable 0-10 mA zero end, 5-50 mA full-scale end) with 500 Ω max loop resistance for 20A (200 Ω for 50 mA). Also 0-10V (maximum) available with proper selection of load resistor.

Calibration Points: 216°F (102°C), 428°F (220°C)
759°F (404°C), 1378°F (748°C)
ZERO/FULL SCALE milliamps

Emissivity: 0.10 to 0.99 in 0.01 steps

Peak Hold: No hold to infinite hold, expressed as percent held after one second. Reset with 600 millisecond minimum external contact closure

Fail Safe: Most component or system failures, at any time, produce a full scale output to shut down process

Environment:

Main Unit: Operating: 32° to 120°F (0° to 50°C) Sealed to NEMA 12

Standard Sensing Head: Operating: 10° to 150°F (−20° to 65°C)
Sealed to NEMA 12

Storage: −40° to 150°F (−40° to 65°C) Relative humidity up to 85% non-condensing.

Dimensions:

Main Unit: H: 10″ (254 mm) × W: 8″ (203 mm) × D: 2″ (51 mm); Sealed to NEMA 12

Standard Sensing Head: 1.5″ (38 mm) diameter, 6.25″ (159 mm) long, excluding cable

Sensing Head Cable: 25 feet (7.6 meters) standard.

Weight:

Main Unit: 8 lbs., 10.5 oz. (3.93 Kg)
Standard Sensing Head: 15.5 oz. (0.44 Kg)

Input Voltage: 115 or 230 V ac ±10%, 50/60 Hz, user selectable. (10 VA)

How to Order:

OS-1000-110V: OMEGASCOPE II unit, complete with sensing head, integral 25 ft. cable, and display/control NEMA 12 enclosure. Initially wired for 110 Volt operation. **$1495**

OS-1000-220V: Same unit as OS-1000-110V, but initially wired for 220 Volt operation. **$1495**

ACCESSORIES

Model No.	Description	Price
OS-1000-93	Head Mounting Nut	$ 15
OS-1000-38	Fixed Mounting Bracket	25
OS-1000-27	Air Purge Collar	75
OS-1000-11	Water Cooled Shell	225
OS-1000-92	Pipe Adaptor	50
OS-1000-35	Conduit Adaptor	60
OS-1000-02	Mounting Flange	25
OS-1000-SH	Replacement standard sensing head, with 25 ft. integral cable	375
OS-1000-CD	Replacement control/display main unit in NEMA 12 enclosure	1125

Portable Pyrometer for Heavy Duty Service

Model 8020

$ 160

- Bimetal Compensated for Ambient Temperature Changes
- 1% Accurate Mirrored Meter of Full Scale
- Several Ranges Available
- No Power Needed
- 3.85 Ohm Probes

***BE SURE TO MATCH CALIBRATION OF METER AND PROBE, I.E. TYPE E WITH TYPE E PROBE.**

The portable pyrometer Model 8020 features a 1% accurate standard taut-band meter in a rugged, attractively styled case. The self-contained package allows quick spot checking of temperature.
No power is needed.

Compensates for ambient temperature changes. Meters are mirrored and protected by glass windows. Cases are aluminum trimmed ABS plastic, black with textured finish.

Model 8020, 7¼″ wide by 4¼″ high by 10¼″ long, weighs approximately 3 pounds. Its thin-front Model 8020 pyrometer is mounted behind a gasketed glass window. The carrying case lid has storage space for several probes. Calibration is 3.85 ohms in types E and K thermocouple ranges, with a 10 ohm internal adjustable resistor strip. Pyrometers are factory adjusted to read correctly with 3.85 ohm type E and type K thermocouples. The 3.85 ohm external resistance rating can be increased to 10 ohms by means of an internal adjustment.

Please note: Any 5½″ meter in Section L can be incorporated into an OMEGA 8020 Portable Pyrometer. There is no additional charge for this service.

Ranges: Model 8020 portable pyrometer
All ranges $160 without probes.
All ranges in stock.
Additional Calibrations Are Available—Consult Sales Department

Ranges	Stock**Thermocouple Calibrations	Catalog Designation
0-2500°F	K	PY-8020-K-2500
0-2000	K	PY-8020-K-2000
0-1500	E	PY-8020-E-1500
0-800	E	PY-8020-E-800
0-500	E	PY-8020-E-500
0-300	E	PY-8020-E-300
−75 to +225	E	PY-8020-E-225A
−200 to 100	E	PY-8020-E-100B
−100 to 1100	E	PY-8020-E-1100A
−100 to 600	E	PY-8020-E-600A

* * See Section L—Additional Calibrations Are Available—Consult Sales Department

FASTEMP®
Miniature Thermometer and Probes

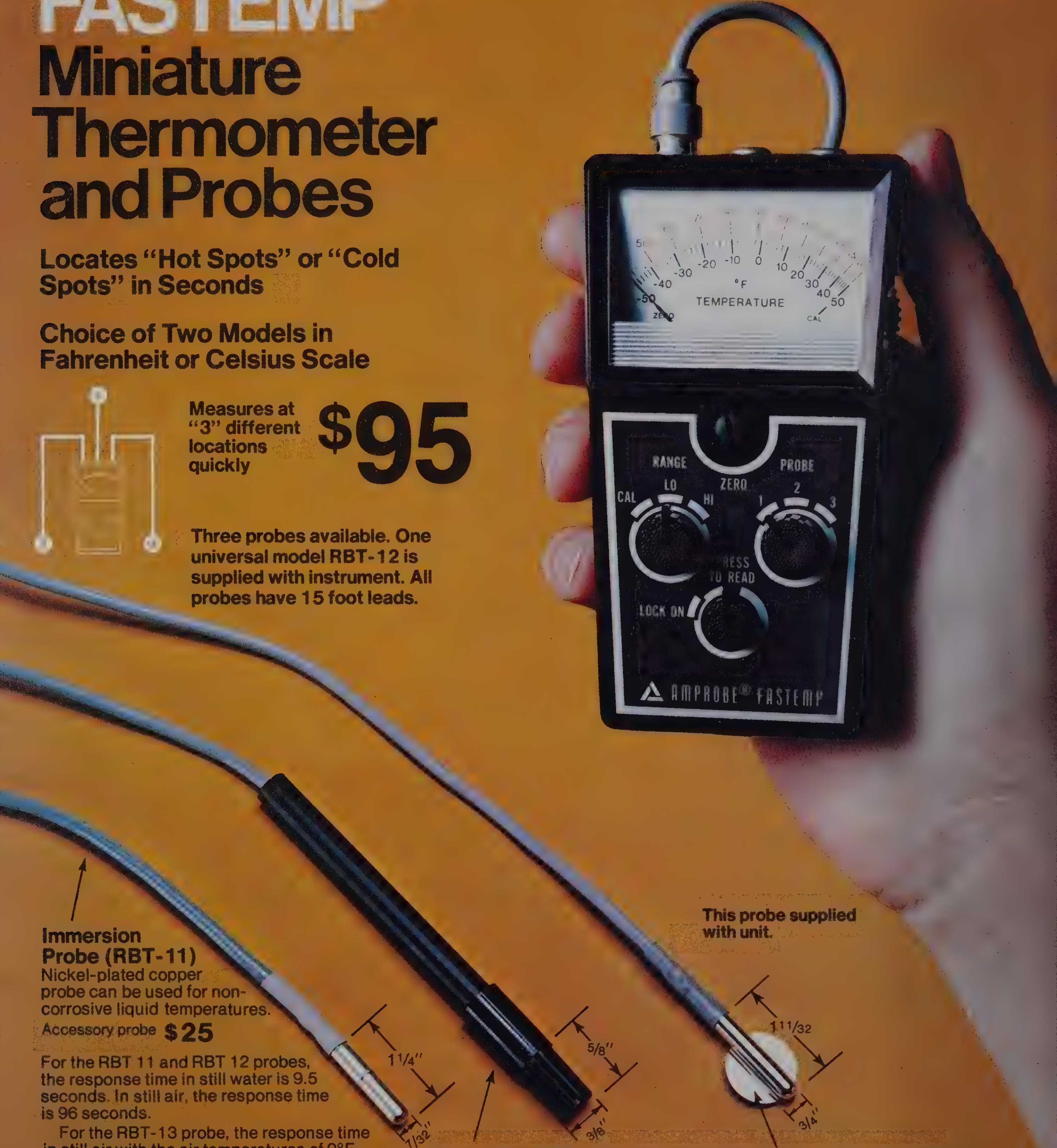
Locates "Hot Spots" or "Cold Spots" in Seconds

Choice of Two Models in Fahrenheit or Celsius Scale

Measures at "3" different locations quickly

$95

Three probes available. One universal model RBT-12 is supplied with instrument. All probes have 15 foot leads.


-50
-40
-30
-20
-10
0
10
20
30
40
50
°F
TEMPERATURE
ZERO
CAL
RANGE
LO
HI
CAL
ZERO
PROBE
1
2
3
PRESS TO READ
LOCK ON
AMPROBE® FASTEMP
1 1/4"
7/32"
5/8"
3/8"
1 11/32
3/4"

This probe supplied with unit.

Immersion Probe (RBT-11)

Nickel-plated copper probe can be used for non-corrosive liquid temperatures.

Accessory probe **$25**

For the RBT 11 and RBT 12 probes, the response time in still water is 9.5 seconds. In still air, the response time is 96 seconds.

For the RBT-13 probe, the response time in still air with the air temperatures of 0°F and 100°F, at the end of 55 seconds, the probe will achieve 63 percent of the change.

Air Probe (RBT-13)

Vented housing permits free flow of air for rapid sensing of temperatures. For air or non-corrosive gaseous temperatures.

Accessory probe **$25**

Universal Probe (RBT-12)

Nickel-plated copper probe can be used for non-corrosive gaseous, liquid or surface temperatures.

Supplied with instrument

$25 each for extra probes

Fast • Compact • Accurate • Versatile • Unique

AMPROBE® FASTEMP® Thermometer

$95

Battery Powered Dual Range Industrial Thermometer

Model	Ranges Low	Ranges High	Scale Div.	Price
T-150F	−50°F to +50°F	+40°F to +150°F	2°F	$95
T-65C	−45°C to +10°C	+6°C to +65°C	2°C	
T-250F	+10°F to +110°F	+100°F to +250°F	*	
T-120C	−12°C to +43°C	+38°C to +120°C	2°C	

*2°F Low Range; 5°F High Range

Complete with one Universal probe and 4 "AA" batteries.
Also available: 15 ft extension leads. $25. Part # — RBT-X.

TEMPERATURE
°F
RANGE
LO
HI
CAL
ZERO
PROBE
1
2
3
PRESS TO READ
LOCK ON
AMPROBE® FASTEMP

- **Fast!** Measure temperature in seconds.
- **Compact!** Fits palm or pocket.
- **Lightweight!** Weighs 10 oz.
- **Accurate!** Within ± 2% of range span
- **Versatile!** Check surface, liquid or gaseous temperatures.
- **Different!** Unique "Press to Read" button greatly extends battery life. "Locks in" for continuous readings.
- **Size:** $4\frac{3}{16} \times 2\frac{11}{16} \times 1\frac{7}{8}$ in.

Range overlap permits monitoring of changing temperature without frequent switching of ranges.

OMEGA
RANGE
LO
HI
CAL
ZERO
PROBE
PRESS TO READ
LOCK ON
AMPROBE® FASTEMP

Complete kit with all three probes— in Celsius or Fahrenheit Scale

Four models available

Complete Kit — All three probes, carrying case and batteries

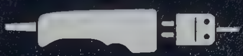
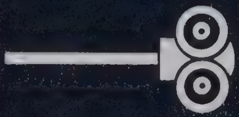
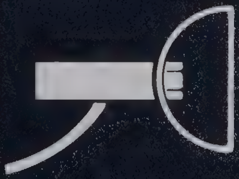
Choice of Models	**XT-150F**	Fahrenheit scale	$ 170
	XT-65C	Celsius scale	170
	XT-250F	Fahrenheit scale	170
	XT-120C	Celsius scale	170

AMPROBE and FASTEMP are registered trade names of AMPROBE Instrument, Division of SOS Consolidated, Inc.

THERMOCOUPLE PROBES AND SENSORS KIT
THERMOCOUPLE TYPE: ☐J, ☒K, E
PRODUCT DESIGNATION
1. SP-EH-4
2. SP-RL-☐-3½"-SMP
3. SP-RA-☐-3½"-SMP
4. SP-SP-☐-3½"-SMP
5. S SS-032G-6
6. S SS-062G-6
7. S SS-125G-6
8. SP-BW-☐-3 ft-SMP
9. 2 pair SMP-☐-MF
10. 2 ft-AGH-☐-225-SB-SMP-MF
11. 25 ft-TT-☐-30
12. RSC-☐-1-4-5
☐ Insert thermocouple type J, K or E
Insert IC for type J, CA for type K or CX for type E
OMEGA
OMEGA ENGINEERING, INC.
METAL
INSULATION
DATE
LENGTH
SIZE
OMEGA
ENGINEERING, INC.
An OMEGA Group Company
Model 871
Digital

D

Hand held and Surface Thermocouple Probes

Quick Disconnect Probes for HDX Handle		D-3
NEW New Style Handle Heavy Duty Probes		D-4
Special Purpose Surface Probes		D-5
Probe and Sensor Kit		D-8
Heavy Duty Probes		D-10
High Temperature Surface Probes		D-11

Quick Disconnect Handle/

High Impact Plastic Handle Style SDX

General Purpose Probe

$27

Sold separately. See page A-9.

SDX Handle
$25
Sold separately. See page G-5.

Order a Complete Handle and Probe Combination! SAVE $10

- 6 Custom Measuring Tips Available
- Choice of 2 Handle Styles
- Complete Probe Interchangeability
- Compatible with Hand Held Instruments
- 1 foot Retractable Cord

How to Order

High Impact Plastic Handle
SDX-SET-1-2-3

Rugged Aluminum Handle
HDX-SET-1-2-3

Ordering a Probe/Handle Set is as easy as 1, 2, 3.

1. Specify one of the six probe styles shown.
2. Specify thermocouple calibration J, K, T, E.
3. Specify the desired connector on the cord end.

Note:
Probe style determines the handle connector. Standard QD probes have OST connectors. Subminiature probes have SMP subminiature connectors. For special applications, grounded probes are available with the HDX handle (not available with air and subminiature probes). To order, specify "OTP" termination for the cord connector. 5 ft. of metal overbraided thermocouple wire will be supplied instead of the retractable cord; **Add $10** to the kit price.

Pricing:
The price of the set is determined by the probe style selected. Set prices are shown with the probe styles. For probes with 3-pin connectors and true grounding, **Add $10.** For the bent surface probe style shown on page D-5, specify "SP-60° bend". **Add $6.**

J	Iron-Constantan		T	Copper-Constantan
K	Chromel-Alumel		E	Chromel-Constantan

See Section A for more probes!

Probe Sets

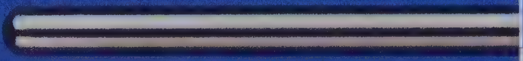
Rugged Aluminum Handle Style HDX

Quick Disconnect Probes for Handle Sets

GP

General Purpose
Our most popular style

SDX	HDX
$42	$47

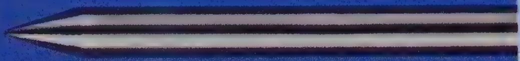


12" Length; ⅛" O.D. Stainless Steel Sheath

NP

Penetration Style

SDX	HDX
$55	$60

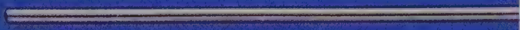


12" Length 3/16" O.D. Conical Point

RT

Fast Response Style

SDX	HDX
$60	$65

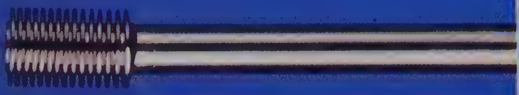


12" Length; Reduced to 1/16" O.D.

SP

Surface Probe

SDX	HDX
$100	$105

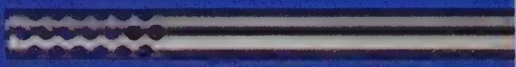


Flexible Tip

AP

Air Probe

SDX	HDX
$95	$100



12" Length 3/16" O.D. Radiant Energy Shield

SM

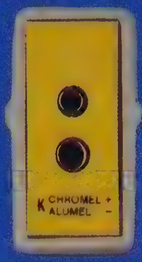
Subminiature

SDX	HDX
$43	$48

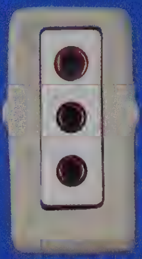
6" Length, 1/16" O.D. Stainless Steel Sheath

See page D-6 for information on standard size probes with custom measurement tips.

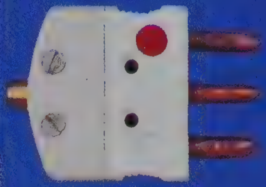
3 Connector Styles

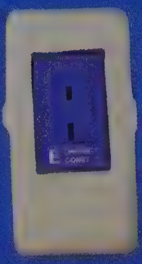


OST-Standard size fits all OMEGA QD probes.

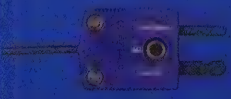


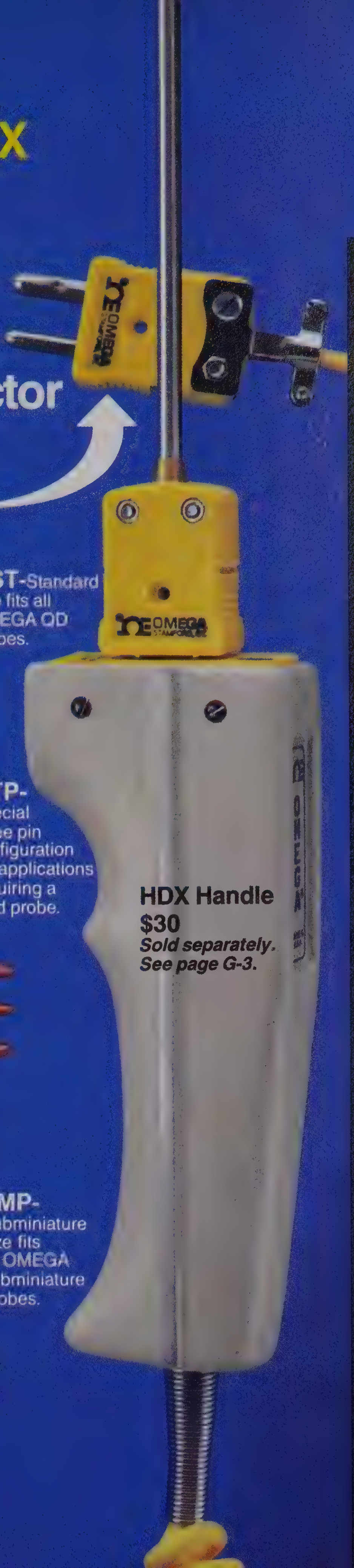
OTP-Special three pin configuration for applications requiring a truly grounded probe.





SMP-Subminiature size fits all OMEGA subminiature probes.

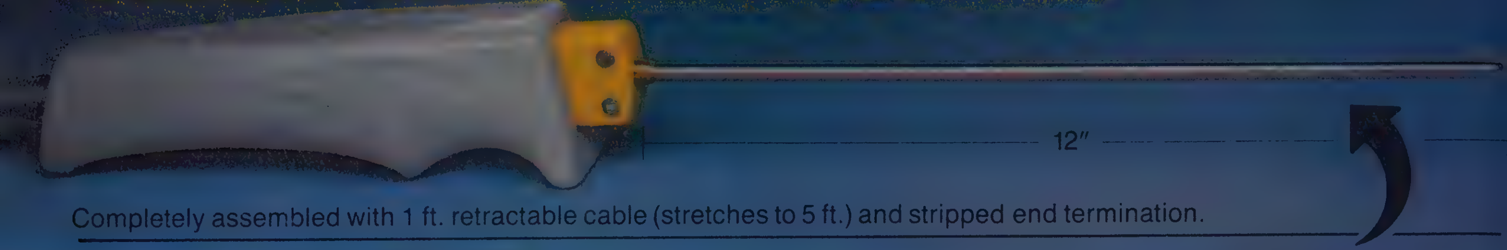




HDX Handle
$30
Sold separately. See page G-3.

Integral Handle Probes NEW!

Custom Measurement Probes



Completely assembled with 1 ft. retractable cable (stretches to 5 ft.) and stripped end termination.

General Purpose Probe

1/8″ O.D. **$32**

Price includes probe with handle

Tip used for air and liquid immersion measurements. Made from rugged 304 stainless steel. Can be used for most heavy duty applications. Tip rated to 1700°F (927°C).

See page A-6 for the complete selection

Penetration Probe

HPS-NP-[*]-316G-12

3/16″ O.D. **$45**

Price includes probe with handle

Tip designed for easy penetration into soft and semi-frozen objects. Made from rugged 304 stainless steel. Tip rated to 1700°F (927°C).

Fast Response Probe

HPS-RT-[*]-18G-12

Reduced to 1/16″ O.D. **$50**

Price includes probe with handle

Special small diameter (1/16″) tip designed for fast response. Made from 304 stainless steel. Tip rated to 1700°F (927°C).

Surface Probe

HPS-SP-[*]-316G-12

3/16″ O.D. **$90**

Price includes probe with handle

Flexible tip which conforms to most surfaces for fast, repeatable, accurate measurements. Made from rugged 304 stainless steel. Tip rated to 500°F (260°C).

Air Probe

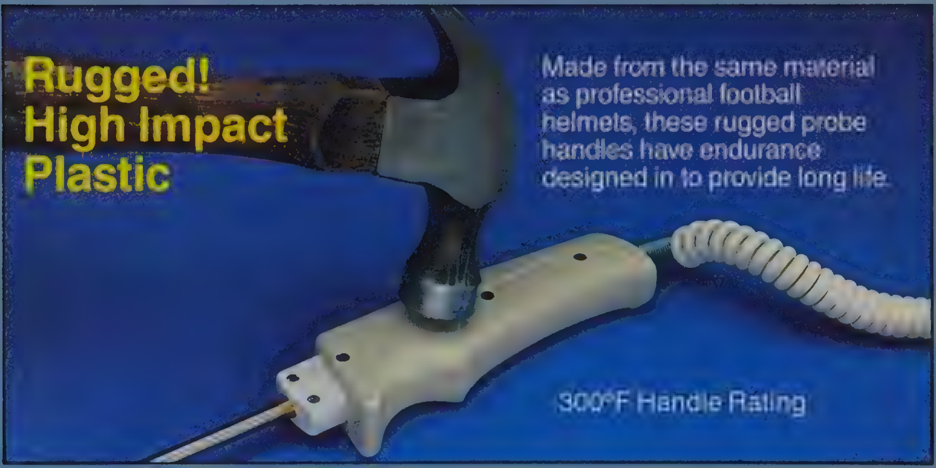
HPS-AP-[*]-316E-12

3/16″ O.D. **$85**

Price includes probe with handle

Radiant energy shield with fine gage wire thermocouple and 304 stainless steel sheath. Thermocouple tip is exposed to air flow for fast measurements and the constant diameter design facilitates easy insertion into duct work, grills and air vents. Tip rated to 500°F (260°C).

**Insert thermocouple type J, K, T, E*



Made from the same material as professional football helmets, these rugged probe handles have endurance designed in to provide long life.

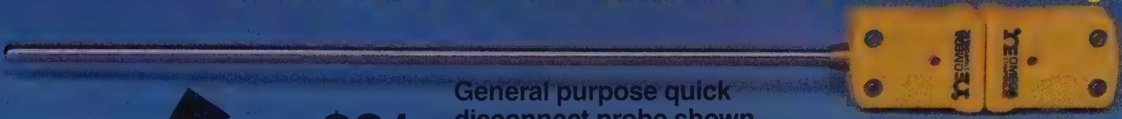
Custom Assemblies Available

Thermocouple probes with integral high impact plastic handles, with 1 ft. retractable cord with stripped leads (other terminations are available). Handles are rated to 300°F.

Probes shown are available in J, K, T and E calibrations. Other sheath and lead lengths are available. Consult Sales Department for details.

Quick Disconnect Probes

Custom Measurement Tips

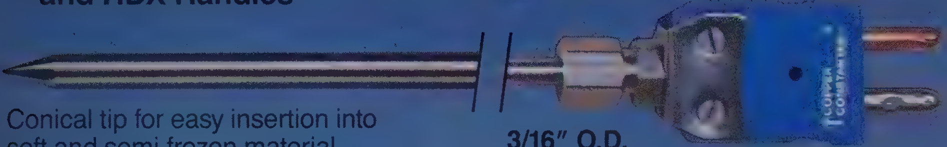


- Color-Coded
- 12″ Length
- For Use with SDX and HDX Handles

$31 General purpose quick disconnect probe shown. See page A-9.

Mating connector supplied

Penetration Probe



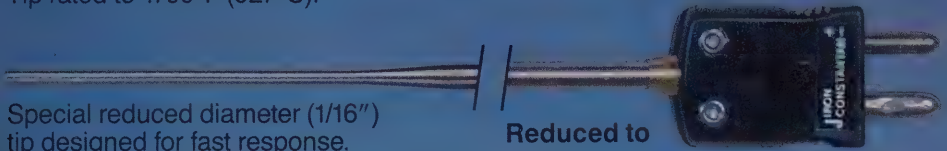
3/16″ O.D.

Conical tip for easy insertion into soft and semi-frozen material. Made from rugged 304 stainless steel. Includes X-BRLK tube clamp for heavy duty applications. Tip rated to 1700°F (927°C).

QD-NP-[*]-316G-12

$40 HDX & SDX Handles Sold Separately See page G-3

Fast Response Probe



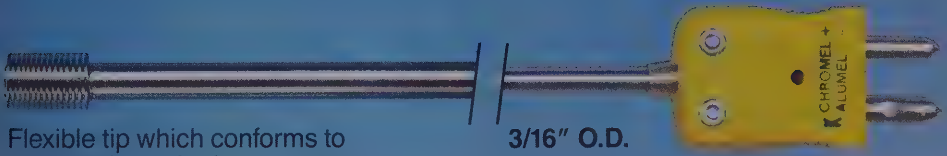
Reduced to 1/16″ O.D.

Special reduced diameter (1/16″) tip designed for fast response. Rugged 304 stainless steel sheath. Tip rated to 1700°F (927°C).

QD-RT-[*]-18G-12

$45 HDX & SDX Handles Sold Separately See page G-3

Surface Probe



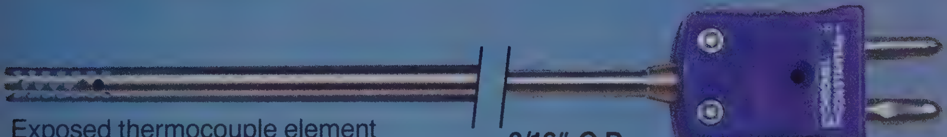
3/16″ O.D.

Flexible tip which conforms to most surfaces for fast, accurate, repeatable measurements. Made from rugged 304 stainless steel. Tip rated to 500°F (260°C).

QD-SP-[*]-316G-12

$85 HDX & SDX Handles Sold Separately See page G-3

Air Probe



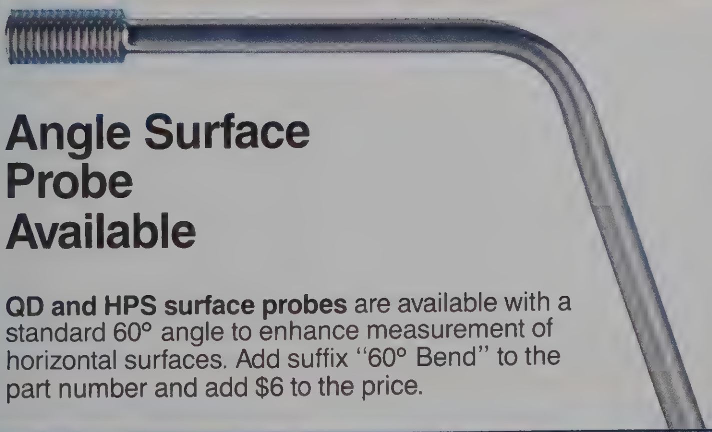
3/16″ O.D.

Exposed thermocouple element shielded by 304 stainless steel sheath. Drilled end exposes bead to airflow for fast measurements. Constant diameter allows for easy insertion or mounting into duct work. Rated to 500°F (260°C).

QD-AP-[*]-316E-12

$80 HDX & SDX Handles Sold Separately See page G-3

**Insert thermocouple type J, K, T, E*



Angle Surface Probe Available

QD and HPS surface probes are available with a standard 60° angle to enhance measurement of horizontal surfaces. Add suffix "60° Bend" to the part number and add $6 to the price.

Custom Assemblies Available

All the probes shown are available in J, K, T and E calibrations, and are designed for use with SDX and HDX handles found in Section G. Probe lengths other than 12″ are available, consult Sales Department for details.

Unique Surface Probe

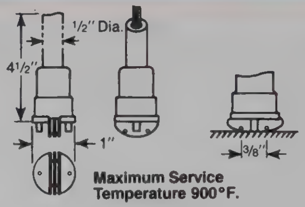
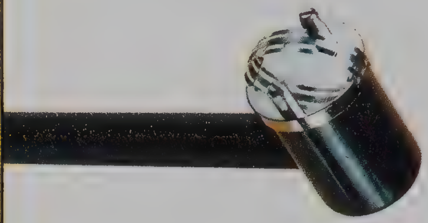
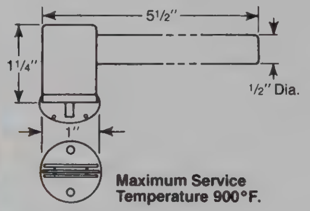
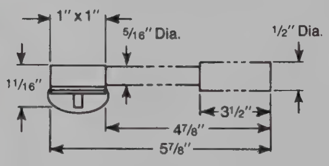
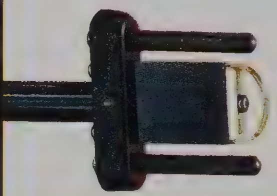
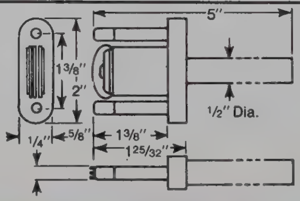
Exclusive—Patented Designs

Series 68000

The OMEGA unique line of surface probes provide accurate, fast temperature measurements for many specialized applications. All are available in type E (Chromel-Constantan) and type K (Chromel-Alumel) and are supplied with approximately 5 feet of lead wire and stripped end terminations. An optional SMP subminiature thermocouple alloy connector is available by adding the suffix "SMP" to the catalog number.

These probes, with the SMP connector, are compatible with many OMEGA digital thermometers including the Model 450 and Model 871 (see Section C for more information on digital thermometers).

Many of OMEGA surface probes are available for OFF-THE-SHELF delivery.

	Configuration	Catalog No./Description	Price
	 Maximum Service Temperature 900°F.	**Catalog No. 68001-☐** Best suited for measuring temperatures of molds, plates, walls, glassware, dies, bearings and other stationary surfaces.	$120
	 Maximum Service Temperature 900°F.	**Catalog No. 68101-☐** Ideal for hard-to-reach inside surfaces.	$120
	 1" x 1" 5/16" Dia. ½" Dia. 1 1/16" 3½" 4 7/8" 5 7/8" Maximum Service Temperature 900°F.	**Catalog No. 68103-☐** The narrow head on this probe allows it to fit through small openings.	$120
	 5" 1 3/8" 2" ½" Dia. ¼" 5/8" 1 3/8" 1 25/32" Maximum Service Temperature 320°F.	**Catalog No. 68005-☐** Supports on both sides of the head provide support for fast measurements on flat surfaces. The probe is only ¼" wide for measurement on small surfaces.	$120

- Accurate, stable and fast surface temperature measurements are now possible with OMEGA interchangeable surface temperature probes.
- Many standard probe styles available from stock.
- Companion output meters available—Seven ranges.
- Supplied with approximately five foot leads.
- Type E elements and Type K elements available.
- Ideal for use on metals, plastics and ceramics.

Ordering Information

All probes are available with either type E or type K elements. Probes supplied with stripped end terminations have approximately 5 foot leads with a loop resistance of 3.85 ohms, making them interchangeable when used with an analog pyrometer such as the OMEGA PY-8020.

For use with digital instruments specify the optional SMP subminiature connector by adding the suffix "SMP" to the catalog number, and $5 to the price.

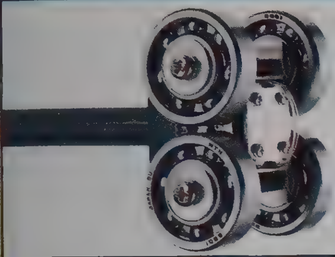
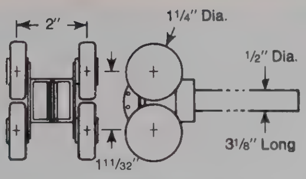
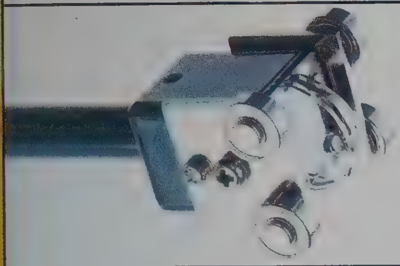
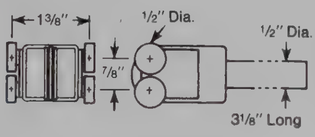
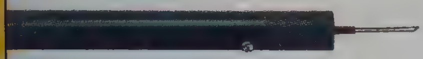
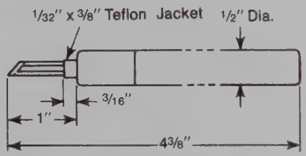
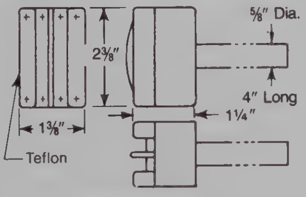
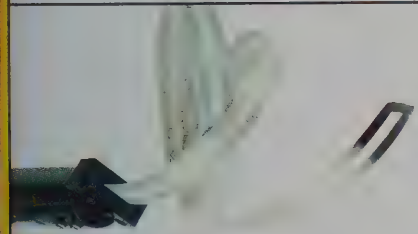
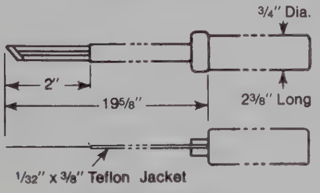
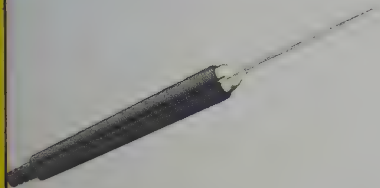
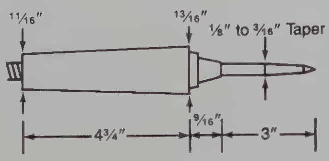
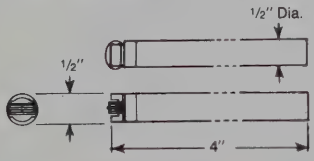
Ordering Example

To order Series 68000 Probes, fill in box with Code "E" for Chromel-Constantan or Code "K" for Chromel-Alumel.

Add suffix "SMP" if connector is desired.

Add $5 to price for SMP connector.

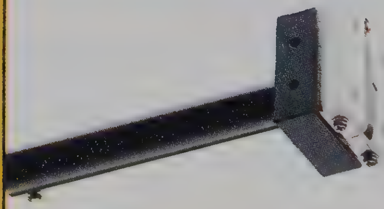
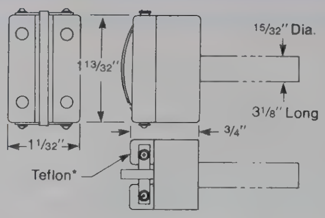
Example: 68227-E-SMP
Type E (Chromel-Constantan) Surface Probe with a male SMP subminiature connector.

	Configuration	Catalog No./Description	Price
	 **Maximum Service Temperature 400°F.**	**Catalog No. 68202-☐** Use on moving and rotating smooth surfaces of 22 to 60 inches diameter. Maximum surface velocity not to exceed 300 feet per minute. Ideal for measuring the outside wall temperature of smooth plastic and steel pipe and tanks.	$140
	 **Maximum Service Temperature 400°F.**	**Catalog No. 68203-☐** Use on rotating, smooth metallic and plastic surfaces of 9 to 24 inches diameter. Maximum surface velocity not to exceed 300 feet per minute. Ideal for measuring the outside wall temperature of plastic and steel tube and pipe.	$155
	 **Maximum Service Temperature 420°F.**	**Catalog No. 68303-☐** Short leaf-type thermocouple is ideal for measuring layers of plywood, plastic, rubber, paper and various laminate materials. The thermocouple is 0.010 inch by .028 inch and protected with a .020 inch Teflon jacket.	$ 61
	 **Maximum Service Temperature 480°F.**	**Catalog No. 68221-☐** Ideal for measuring the surface temperature of moving or stationary, smooth flat surfaces. Equally effective on metal and plastic surfaces. Maximum surface velocity of moving surfaces should not exceed 300 feet per minute.	$125
	 ¾" Dia. 2" 19⅝" 2⅜" Long 1/32" x ⅜" Teflon Jacket **Maximum Service Temperature 420°F.**	**Catalog No. 68304-☐** Flat leaf-type thermocouple similar to No. 68303 where longer length is required. The thermocouple is .006 inch thick and is protected with a .032 inch Teflon jacket about 18 inches long.	$ 73
		**Catalog No. 68301-☐** Suitable for measuring the internal temperatures of semi-solid materials such as rubber, plastics, clay, etc. Can be used in liquids as well. Sheath material of probe is stainless steel.	$ 91
	 **Maximum Service Temperature 480°F.**	**Catalog No. 68007-☐** Miniature, rapid response surface probe similar in construction to Model #68001. Response time is 0.5 to 2 seconds for metal surfaces and 3 to 10 seconds for nonmetallic surfaces. Ideal for measuring the surface temperature of small electronic parts.	$120

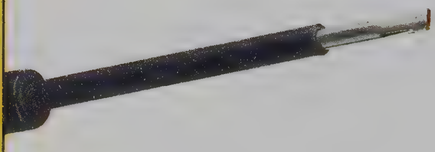
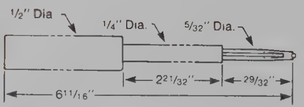
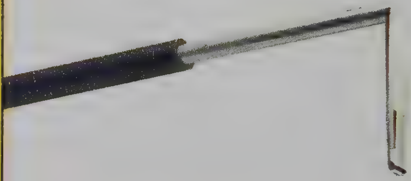
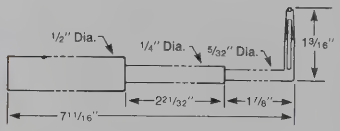
Unique Surface Probe

Special Applications
Series 68000

Interchangeable Thermocouples and Surface Pyrometers

Configuration	Catalog No./Description	Price
  15/32" Dia. 1 13/32" 3 1/8" Long 3/4" 1 1/32" Teflon* **Maximum Service Temperature 480°F.**	**Catalog No. 68227** ☐ New smaller design for moving or stationary flat surfaces. The sensing element has end braces to minimize flexing due to a moving surface and to prolong probe life. Teflon sliders ensure smooth operation on metal or plastic surfaces. Maximum surface velocity should not exceed 200 feet per minute.	$125

Micro-Sensor Probes

  1/2" Dia 1/4" Dia. 5/32" Dia. 2 21/32" 29/32" 6 11/16" **Maximum Service temperature: 750°F. Teflon tip models: 400°F**	**Catalog No. 68008** ☐* Developed for precision measurements of small surface areas such as transistors and ICs, the unique lateral spring design has a contact surface of only .040" by .118". The result is a very fast responding probe. Because of its size and lightweight materials, the probe must be handled with care and properly stored to prevent damage. A quality vinyl case is provided to protect the probe during storage.	$120
  1/2" Dia. 1/4" Dia. 5/32" Dia. 13/16" 2 21/32" 1 7/8" 7 11/16" **Maximum Service temperature: 750°F. Teflon tip models: 400°F**	**Catalog No. 68104** ☐* Developed for small precision measurements where a right-angle probe is needed, the unique lateral spring design has a contact surface of only .040" by .118" for fast, accurate measurements of small devices such as transistors and ICs. The result is a very fast responding probe. Because of its size and lightweight materials, the probe must be handled with care and properly stored to prevent damage. A quality vinyl case is supplied to protect the probe during storage.	$125

Vinyl case is provided to protect NEW Micro-Sensor probes during storage.

*The **Model 68008** and **Model 68104** are also available with a Teflon-coated measuring surface to minimize wear and protect component parts. Specify "Teflon Tip" after the catalog number and add $20 to the price.

Extra Heavy-Duty Thermocouple Probes and Sensor Kits

TK2 Kit

A Kit Within a Kit

A complete temperature measurement laboratory—Probe and Sensor Kit in a high impact plastic case with the digital thermometer of your choice.

Model No. TK2

$299

Plus Meter Price

Total price depends upon digital readout selected. $524 as shown with Model 871.

Also Available!

TK1 Kit $299

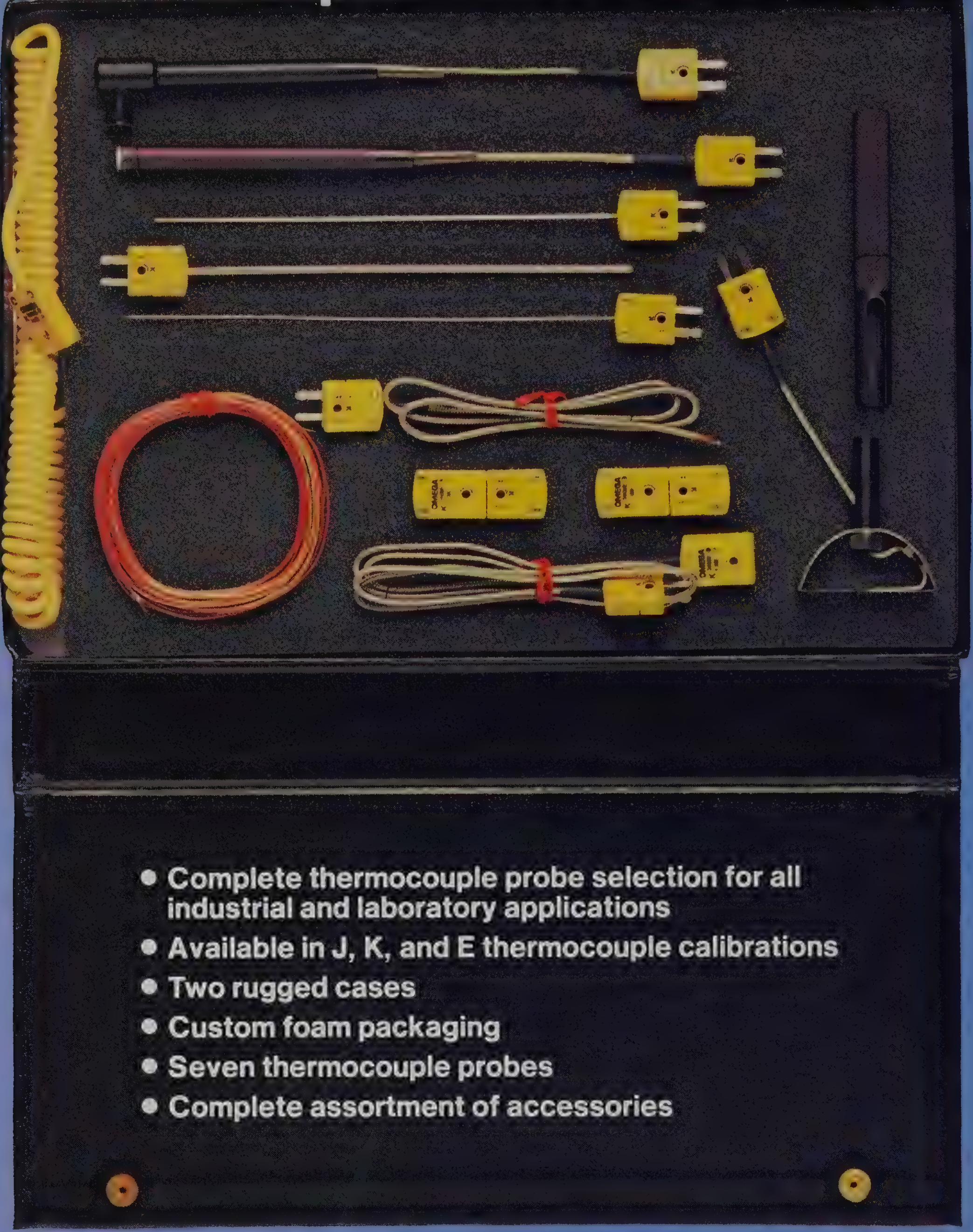
Probes, thermocouple alloy extension wire and connectors—all in an attache style case.
(Shown on next page.)

See Section C for the complete selection of OMEGA hand held digital thermometers.

Added Feature!

Model SDX high impact plastic handle with retractable cable. Fits most probes in kit.

Thermocouple Probes and Sensors



- Complete thermocouple probe selection for all industrial and laboratory applications
- Available in J, K, and E thermocouple calibrations
- Two rugged cases
- Custom foam packaging
- Seven thermocouple probes
- Complete assortment of accessories

TK1 Kit

Professional attache style kit.
Catalog No. TK1.

$299

Contents of Kits

Thermocouple Probes

Surface Probe. Spring-loaded sensor gives fast, accurate readings.

Right Angle Probe. A special right-angle design for tight places.

Roller Surface Probe. Flexible sensor area conforms to curved surfaces.

Beaded-wire Probe. Exposed junction gives fast response in gas and air.

Three Miniature Sheath Probes. Diameters of $\frac{1}{32}$″, $\frac{1}{16}$″, and $\frac{1}{8}$″ with 6″ SS sheath.

Accessories

Retractable Sensor Cable with subminiature connectors. Stretches to five feet.

2 Ft. Armored Extension Cable. Stainless Steel overbraiding on 22-gage thermocouple wire with subminiature connectors.

25 Ft. Thermocouple Wire. 30-gage Teflon-insulated thermocouple wire.

Subminiature connectors. Two pairs of OMEGA's SMP thermocouple connectors.

How to Order

To order OMEGA's new probe and sensor kits, please specify catalog number, thermocouple calibration and hand-held digital thermometer (TK2 kit only).

TK1 - ☐ - $299
↑
Specify calibration K, E, or J

TK2 - ☐ - ☐ $299 + Digital Thermometer
↑ Specify calibration, K or E
↑ Specify digital thermometer

TK2 Kit is now available in Type J.

Digital Thermometers for TK2
Model 727C Type **K** add **$149**
Model 727F Type **K** add **$149**
Model 871 Type **K** add **$225**
Model 450AET Type **E** add **$275**

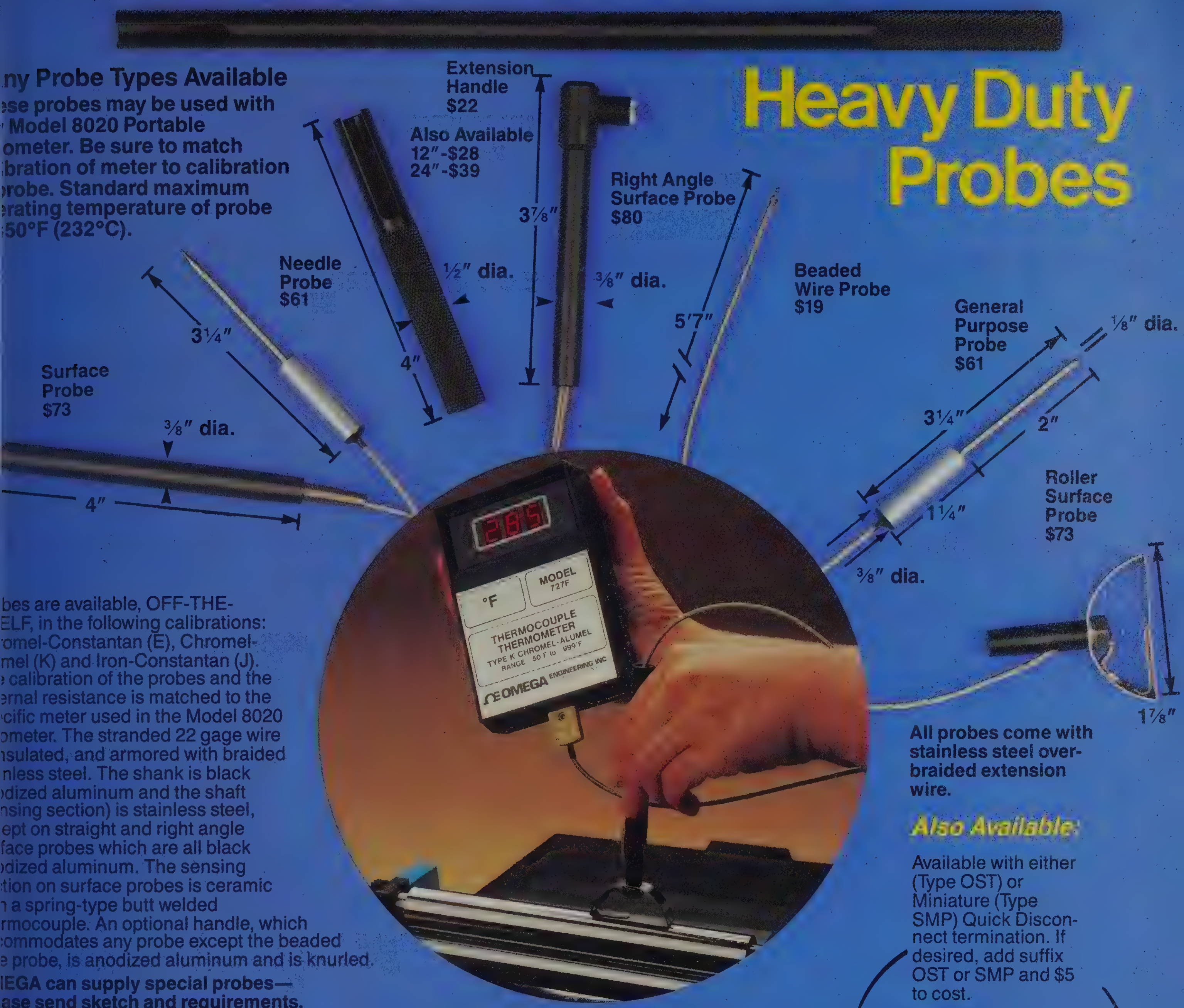
Examples: TK1 - J. Type J Probes and Sensors in attache case. Price: **$299**

TK2 - K - 871 Type K Probes and Sensors in rugged plastic case with a Model 871 Digital Thermometer. Price: **$299** Probe and Sensor Kit
+ **$225** Model 871 Hand Held Readout
$524 Complete

Heavy Duty Probes

ny Probe Types Available

ese probes may be used with Model 8020 Portable ometer. Be sure to match ibration of meter to calibration robe. Standard maximum erating temperature of probe 50°F (232°C).



Extension Handle $22
Also Available 12″-$28 24″-$39
3⅞″
Right Angle Surface Probe $80
Needle Probe $61
½″ dia.
⅜″ dia.
3¼″
4″
Beaded Wire Probe $19
5′7″
Surface Probe $73
⅜″ dia.
4″
General Purpose Probe $61
⅛″ dia.
3¼″
2″
1¼″
⅜″ dia.
Roller Surface Probe $73
1⅞″
285
°F
MODEL 727F
THERMOCOUPLE THERMOMETER
TYPE K CHROMEL-ALUMEL
RANGE 50°F to 999°F
OMEGA ENGINEERING INC

bes are available, OFF-THE-ELF, in the following calibrations: omel-Constantan (E), Chromel-mel (K) and Iron-Constantan (J). calibration of the probes and the ernal resistance is matched to the cific meter used in the Model 8020 ometer. The stranded 22 gage wire nsulated, and armored with braided nless steel. The shank is black dized aluminum and the shaft nsing section) is stainless steel, ept on straight and right angle face probes which are all black dized aluminum. The sensing tion on surface probes is ceramic a spring-type butt welded rmocouple. An optional handle, which commodates any probe except the beaded e probe, is anodized aluminum and is knurled.

EGA can supply special probes— ase send sketch and requirements.

All probes come with stainless steel over-braided extension wire.

Also Available:

Available with either (Type OST) or Miniature (Type SMP) Quick Disconnect termination. If desired, add suffix OST or SMP and $5 to cost.

OST
STANDARD TERMINATION
SMP

How to Order:

Note: Price includes leads up to 6 feet long.

Type	Catalog Number	Base Price*
Surface Probe	SP-SP -□-□-□	$73
Right Angle Probe	SP-RA -□-□-□	80
Needle Probe	SP-NP -□-□-□	61
Beaded Wire Probe	SP-BW -□-□-□	19
General Purpose Probe	SP-GP -□-□-□	61
Roller Surface Probe	SP-RL -□-□-□	73
Extension Handle	SP-EH -□	22

*For Standard Probes only, for variations CONSULT FACTORY.

How to Construct Part Numbers:

SP-□-□-□-□

Probe Kind

Calibrations:
"K" Chromel-Alumel
"E" Chromel-Constantan
"J" Iron-Constantan

Lead Lengths, Standard Lead Lengths are:
Type K = 3.5 ft.
Type E = 3.0 ft.
Type J = 6.0 ft.
Trimmed to 3.85 Ω

Termination = ST Spade Lugs Standard

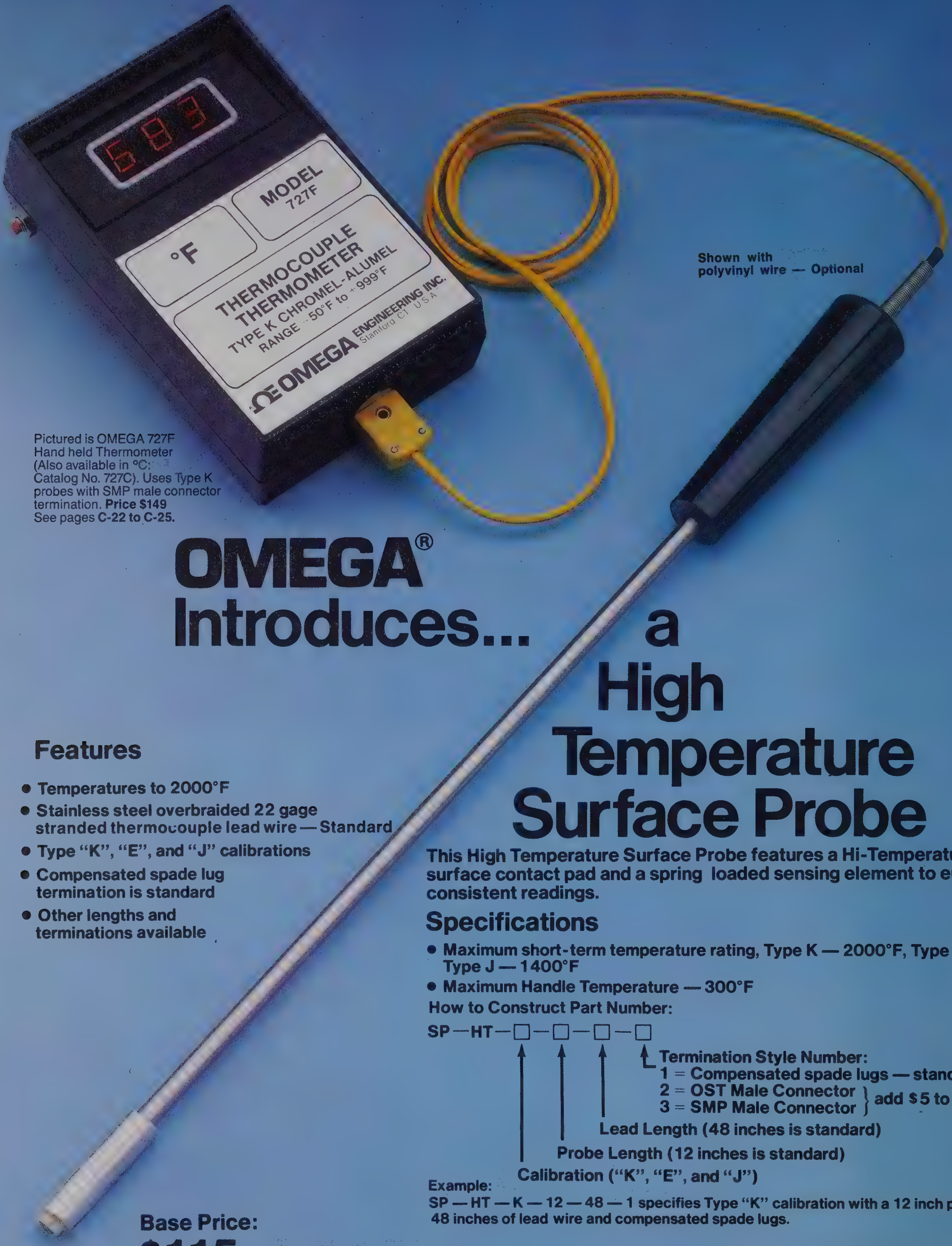
Example: SP-RA-K-3.5-ST

This is a Right Angle Surface Probe, Type K (Chromel-Alumel), 3.5 ft long with spade lugs.

All probes available in K, E and J calibrations "Off-the-Shelf"

Discount Schedule:	
1-10 units	NET
11-24 units	10%
25-100 units	20%
101-500 units	30%
501-1000 units	40%
1001-5000 units	50%

SURE TO MATCH CALIBRATION OF METER AND PROBE, ., TYPE E METER WITH TYPE E PROBE.



Pictured is OMEGA 727F
Hand held Thermometer
(Also available in °C:
Catalog No. 727C). Uses Type K
probes with SMP male connector
termination. **Price $149**
See pages **C-22 to C-25.**

Shown with polyvinyl wire — Optional

OMEGA® Introduces... a High Temperature Surface Probe

Features

- Temperatures to 2000°F
- Stainless steel overbraided 22 gage stranded thermocouple lead wire — Standard
- Type "K", "E", and "J" calibrations
- Compensated spade lug termination is standard
- Other lengths and terminations available

This High Temperature Surface Probe features a Hi-Temperature Alloy surface contact pad and a spring loaded sensing element to ensure consistent readings.

Specifications

- Maximum short-term temperature rating, Type K — 2000°F, Type E — 160
  Type J — 1400°F
- Maximum Handle Temperature — 300°F

How to Construct Part Number:

SP—HT—☐—☐—☐—☐

Termination Style Number:
1 = Compensated spade lugs — standard
2 = OST Male Connector } add $5 to base pric
3 = SMP Male Connector }
Lead Length (48 inches is standard)
Probe Length (12 inches is standard)
Calibration ("K", "E", and "J")

Example:
SP — HT — K — 12 — 48 — 1 specifies Type "K" calibration with a 12 inch probe lengt
48 inches of lead wire and compensated spade lugs.

Base Price:

$115 includes:

- Probe length to 12 inches
- Lead wire to 48 inches
- Spade lug termination

Add:

- $5 for OST or SMP Male Connector
- $5 for each additional 6 inches of probe length
- $2.50 for each additional 12 inches of lead length

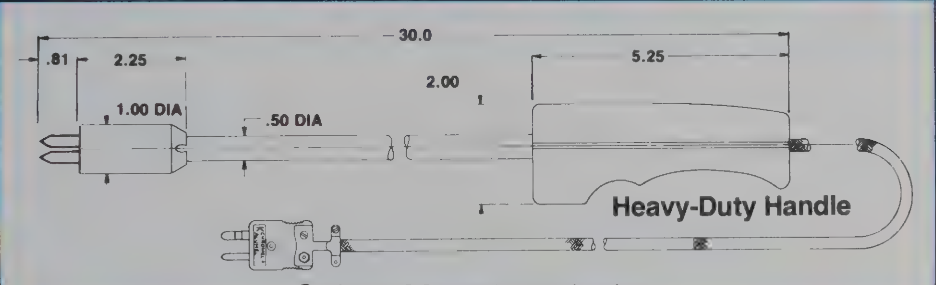
NOTE: This probe cannot be use
with some Non-Amplified Circui
Analog Readout Meters. Consult
factory on application if in doubt.

THE OMEGA SP-HT IS ALSO AVAILABLE WITH RETRACTABLE THERMOCOUPLE CABLE.

Foundry Probe
High Temperature

- **Chromel-Alumel Thermocouple Elements**
- **Measures Hot Metal Surfaces**
- **Rated up to 2300°F (1260°C)**
- **Extra Heavy Duty**
- **¼″ Diameter Contact Elements**
- **Works with High Impedance type K Temperature Readouts**

This extra heavy duty surface probe is designed for use where surface temperatures up to 2300°F (1260°C) and rough handling are encountered. The large heavy duty tips are specially designed to pierce through surface slag and measure the true temperature of the casting. The surface to be measured must be electrically conductive. Lead wire is 16 gage stranded wire with high temperature insulation and stainless steel overbraiding for added protection. Probe is supplied 30″ (762 mm) long as standard. Other lengths are available at additional cost.



Optional OST-Male termination.

Base Price:

$149

Specifications

- Type K thermocouple material
- Maximum temperature 2300°F (1260°C)
- ¼″ pointed elements for long life
- 6 feet leads covered with stainless steel overbraiding
- 30″ (762 mm) probe length
- Thermocouple alloy spade lug termination
- Heavy duty handle

Custom assemblies available!
Contact the Sales Department and send sketch for quotation.

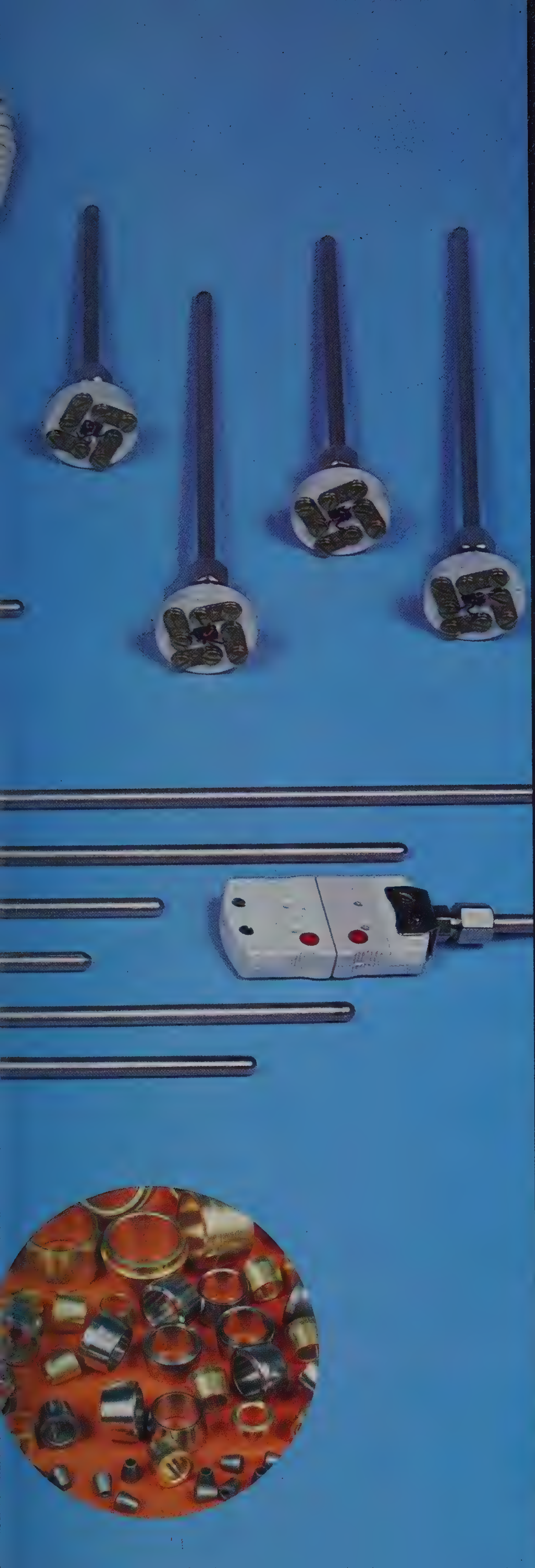
Will not work with analog display systems requiring 10 or 15 ohm input impedance.

How To Order:

SP-HF-K-6.0-☐

Terminations

☐ = SL: Spade Lugs	NC
OST-M: OST Male Connector	**$5**
OGP-M: OGP Male Connector	**$8**



E

RTD Probes and Assemblies

Quick Disconnect Probes and Handles E-3
New Style Handle Probes E-4
General Purpose RTD Probes E-5
Protection Head RTD Probes E-6
Terminal Block Probes and Compression Fittings E-7
RTD Technical Section E-8
Fast Response Thick Film RTD Elements E-10
Wire Wound Ceramic Elements E-11
Wire Wound Glass Elements E-13
Miniature Thin Film Elements E-15

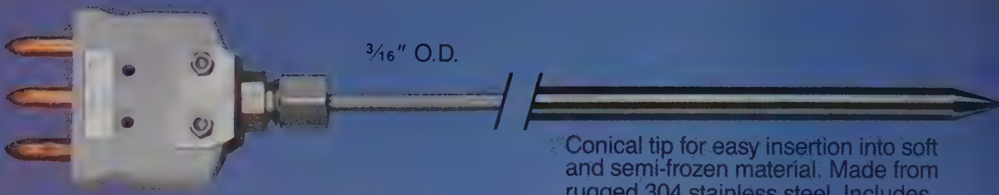
RTD Quick Disconnect Probes
Plug Into OMEGA HDX-RTD Handles

$30 **HDX-RTD** Handle
Handle rated to 300°F
See page G-3

$77 General Purpose **PR-13** probe shown. ***See page E-5 for more RTD Probes.***

Penetration Probe
PRX-NP-100-E-12 inch

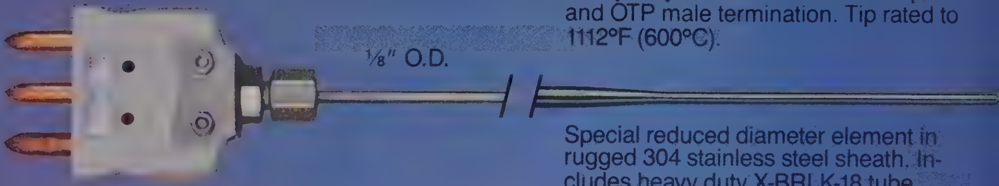
$90 **HDX-RTD Handle Sold Seperately** ***See page G-3.***



Conical tip for easy insertion into soft and semi-frozen material. Made from rugged 304 stainless steel. Includes heavy duty X-BRLK-316 tube clamp and OTP male termination. Tip rated to 1112°F (600°C).

Fast Response Probe
PRX-FR-100-E-12 inch

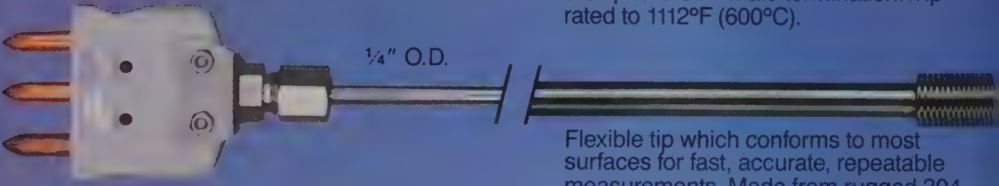
$90 **HDX-RTD Handle Sold Seperately** ***See page G-3.***



Special reduced diameter element in rugged 304 stainless steel sheath. Includes heavy duty X-BRLK-18 tube clamp and OTP male termination. Tip rated to 1112°F (600°C).

Surface Probe
PRX-SP-100-E-12 inch

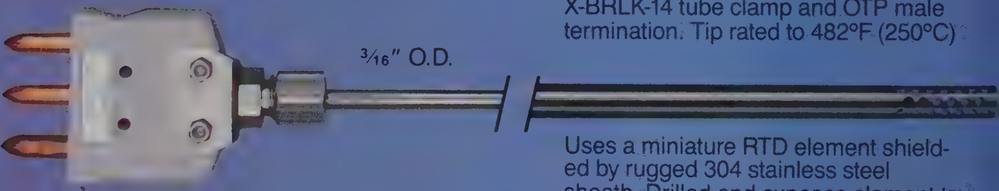
$135 **HDX-RTD Handle Sold Seperately** ***See page G-3.***



Flexible tip which conforms to most surfaces for fast, accurate, repeatable measurements. Made from rugged 304 stainless steel. Includes heavy duty X-BRLK-14 tube clamp and OTP male termination. Tip rated to 482°F (250°C)

Air Probe
PRX-AP-100-E-12 inch

$130 **HDX-RTD Handle Sold Seperately** ***See page G-3.***



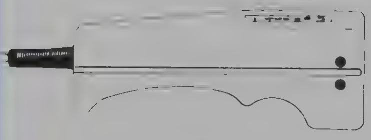
Uses a miniature RTD element shielded by rugged 304 stainless steel sheath. Drilled end exposes element to airflow for fast measurements. Constant diameter allows for easy insertion or mounting into duct work.

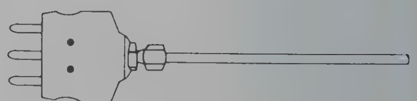
Custom Assemblies Available

All standard probes are supplied with the DIN Standard (European) curve $\alpha = 0.00385$ and 100 ohm resistance. Custom resistances, $\alpha = 0.00392$ and configurations are available. Consult Sales Department.

Make Fast-Sure Connections

These probes plug into the OMEGA HDX-RTD Handle (featured on page G-3).

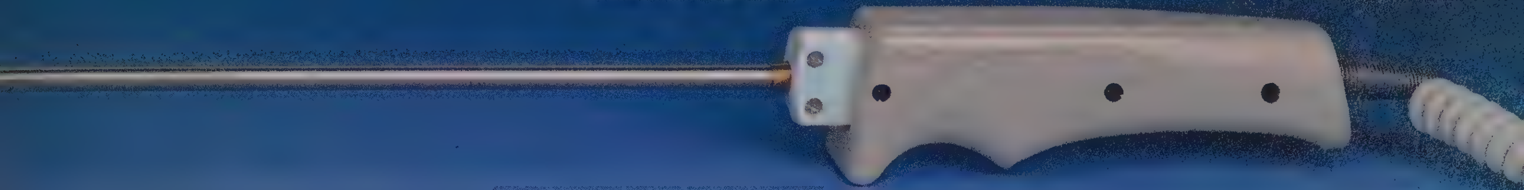




Interchangeable

All PRX probes have DIN tolerance Platinum RTD elements and are totally interchangeable.

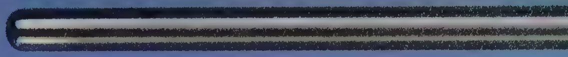
RTD Integral Handle Probes
Custom Measuring Tips



- Low Cost Repairable Construction
- Comfortable Contour Handle
- 300°F Handle Rating
- One Foot Retractable Cord
- Stripped Lead Termination Standard (other terminations available)
- High Impact Plastic Handle

General Purpose Probe with Integral Handle
PRS-GP-100-E-12 inch

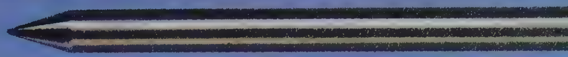
Tip used for air and liquid immersion measurements. Made from rugged 304 stainless steel. Can be used for most heavy duty applications. Tip rated to 1112°F (600°C).



$95 3⁄16″ O.D. complete probe/handle assembly

Penetration Probe with Integral Handle
PRS-NP-100-E-12 inch

Tip designed for easy penetration into soft and semi-frozen objects. Made from rugged 304 stainless steel. Tip rated to 1112°F (600°C).



$105 3⁄16″ O.D. complete probe/handle assembly

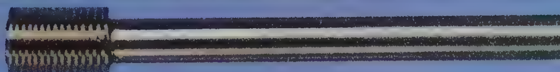
Fast Response Probe with Integral Handle.
PRS-FR-100-E-12 inch

Special small diameter element. Made from rugged 304 stainless steel. Tip rated to 1112°F (600°C).

$105 1⁄8″ O.D. complete probe/handle assembly

Surface Probe with Integral Handle
PRS-SP-100-E-12 inch

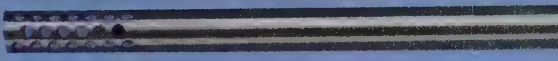
Flexible tip which conforms to most surfaces for fast, repeatable, accurate measurements. Made from rugged 304 stainless steel. Tip rated to 482°F (250°C).



$150 1⁄4″ O.D. complete probe/handle assembly

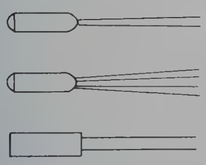
Air Probe with Integral Handle
PRS-AP-100-E-12 inch

Radiant energy shield with a miniature RTD element shielded by 304 stainless steel drilled sheath. Element is exposed to air flow for fast measurements and the constant diameter design facilitates easy insertion into duct work, grills and air vents. Rated 500°F (260°C).



$145 3⁄16″ O.D. complete probe/handle assembly

RTD Elements Available
Hundreds to choose from



Pages E-10 thru E-18

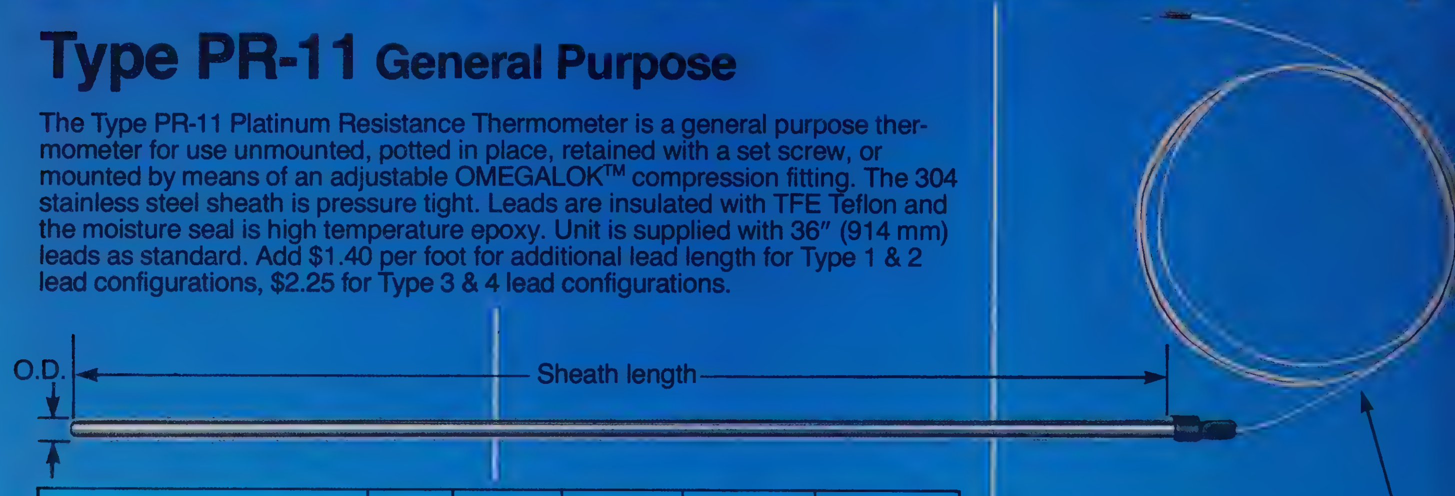
Rugged!
High Impact
Plastic

Made from the same material as professional football helmets, these rugged probe handles have endurance designed in to provide long life.

Resistance Thermometer Probes (RTD)

Type PR-11 General Purpose

The Type PR-11 Platinum Resistance Thermometer is a general purpose thermometer for use unmounted, potted in place, retained with a set screw, or mounted by means of an adjustable OMEGALOK™ compression fitting. The 304 stainless steel sheath is pressure tight. Leads are insulated with TFE Teflon and the moisture seal is high temperature epoxy. Unit is supplied with 36″ (914 mm) leads as standard. Add $1.40 per foot for additional lead length for Type 1 & 2 lead configurations, $2.25 for Type 3 & 4 lead configurations.



Model Number	Lead Type	Ohms at 0°C	Sheath Length	Price ¼″ O.D.	Price ⅛″ O.D.
PR-11-2-100-[*]- 6½-E	2	100	6½″	$66	$72
PR-11-2-100-[*]- 9½-E	2	100	9½″	66	72
PR-11-2-100-[*]-12½-E	2	100	12½″	66	72
PR-11-2-100-[*]-18½-E	2	100	18½″	69	75
PR-11-2-100-[*]-24½-E	2	100	24½″	72	78

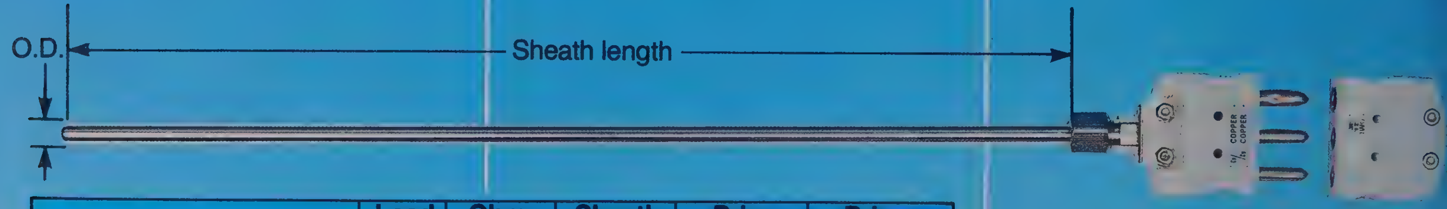
*Replace [ ] with desired diameter, ¼″ or ⅛″

See notes below for additional ordering information.

Standard—Stock Off-the-Shelf Sizes!

Type PR-13 Quick Disconnect

The Type PR-13 RTD is a versatile unit having many applications. The electrical connection is made by a quick disconnect which is supplied attached to the sheath. A mating female connector is also supplied.



Model Number	Lead Type	Ohms at 0°C	Sheath Length	Price ¼″ O.D.	Price ⅛″ O.D.
PR-13-2-100-[*]- 5½-E	2	100	5½″	$77	$90
PR-13-2-100-[*]- 8½-E	2	100	8½″	77	90
PR-13-2-100-[*]-11½-E	2	100	11½″	77	90
PR-13-2-100-[*]-17½-E	2	100	17½″	81	93
PR-13-2-100-[*]-23½-E	2	100	23½″	84	96

*Replace [ ] with desired diameter, ¼″ or ⅛″

See notes below for additional ordering information.

Additional Pricing Information:

For 50 ohm element, add $10 to probe price.
For 200 ohm element, add $10 to probe price.
For 400 ohm element, add $25 to probe price.
For 500 ohm element, add $41 to probe price.
To designate this change, replace the 100 in the above part numbers with the desired resistance value.

Standard probes conform to the European "E" curve ($\alpha = 0.00385$); If the American "A" curve ($\alpha = 0.003916$) is required, change the E to A in the part number.

See Page E-9 for a complete definition of how to order special assemblies.

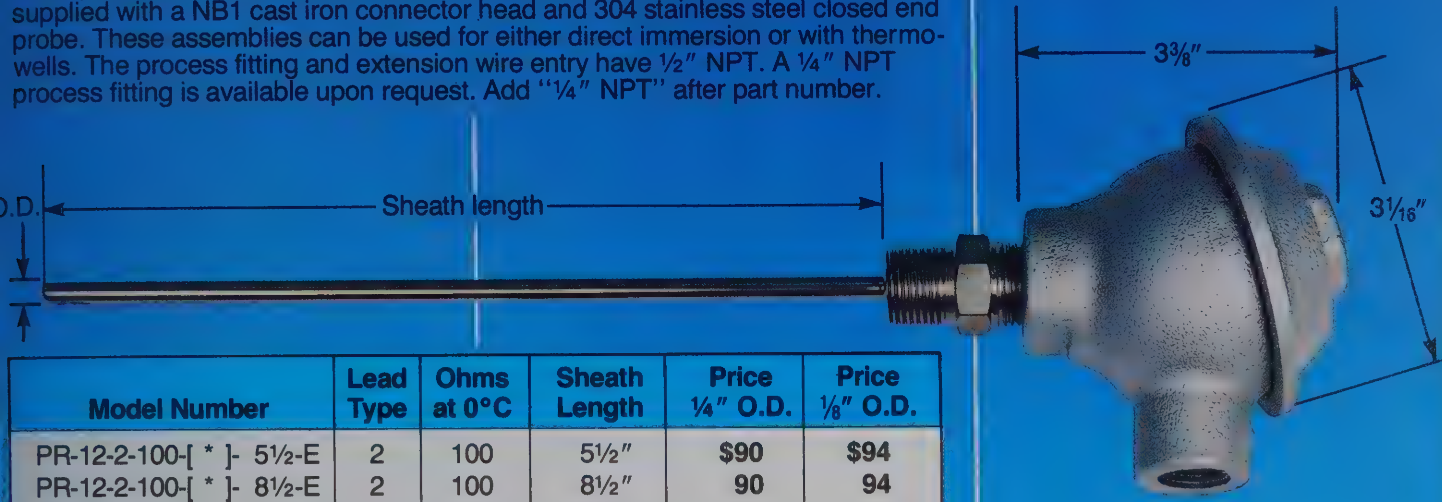
Discount Schedule:

1-25	Net
26-49	10%
50-100	20%

Resistance Thermometer Probes (RTD)

Type PR-12 Cast Iron Connector Head

The Type PR-12 RTD provides cast iron ruggedness at a low cost. The model is supplied with a NB1 cast iron connector head and 304 stainless steel closed end probe. These assemblies can be used for either direct immersion or with thermowells. The process fitting and extension wire entry have ½″ NPT. A ¼″ NPT process fitting is available upon request. Add "¼″ NPT" after part number.



Model Number	Lead Type	Ohms at 0°C	Sheath Length	Price ¼″ O.D.	Price ⅛″ O.D.
PR-12-2-100-[*]- 5½-E	2	100	5½″	$90	$94
PR-12-2-100-[*]- 8½-E	2	100	8½″	90	94
PR-12-2-100-[*]-11½-E	2	100	11½″	90	94
PR-12-2-100-[*]-17½-E	2	100	17½″	93	97
PR-12-2-100-[*]-23½-E	2	100	23½″	99	100

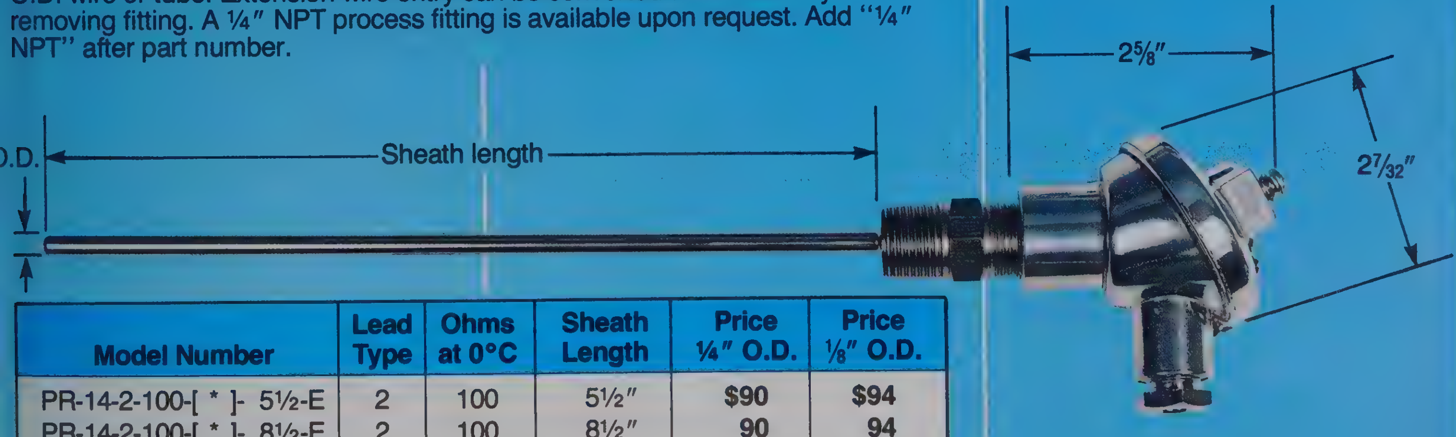
*Replace [ ] with desired diameter, ¼″ or ⅛″

See notes below for additional ordering information.

Standard—Stock Off-the-Shelf Sizes!

Type PR-14 Miniature Aluminum Head

OMEGA's type PR-14 is supplied with a miniature, lightweight NB2 burnished aluminum head with corrosion-resistant features. These assemblies include a 304 stainless steel closed end probe and can be used in either direct immersion or thermowell applications. Process fitting is ½″ NPT standard and extension wire entry has rubber grommet compression fitting which accepts ⅛″ to ¼″ O.D. wire or tube. Extension wire entry can be converted to ½″ NPT by removing fitting. A ¼″ NPT process fitting is available upon request. Add "¼″ NPT" after part number.



Model Number	Lead Type	Ohms at 0°C	Sheath Length	Price ¼″ O.D.	Price ⅛″ O.D.
PR-14-2-100-[*]- 5½-E	2	100	5½″	$90	$94
PR-14-2-100-[*]- 8½-E	2	100	8½″	90	94
PR-14-2-100-[*]-11½-E	2	100	11½″	90	94
PR-14-2-100-[*]-17½-E	2	100	17½″	93	97
PR-14-2-100-[*]-23½-E	2	100	23½″	99	100

*Replace [ ] with desired diameter, ¼″ or ⅛″

See notes below for additional ordering information.

For 50 ohm element, add $10 to probe price.
For 200 ohm element, add $10 to probe price.
For 400 ohm element, add $25 to probe price.
For 500 ohm element, add $41 to probe price.
To designate this change, replace the 100 in the above part numbers with the desired resistance value.

Standard probes conform to the European "E" curve ($\alpha = 0.00385$): If the American "A" curve ($\alpha = 0.003916$) is required, change the E to A in the part number.

See Page E-9 for a complete definition of how to order special assemblies.

Discount Schedule:

1-25	Net
26-49	10%
50-100	20%

Terminal Block RTD Probes

Type PR-15

- **Color coded Terminal Block**
- **100 Ω, Standard**
- **304SS Sheath**
- **1112°F (600°C) Temperature Limit on Tip****
- **Easy Installation Using OMEGALOK™ Compression Fittings**

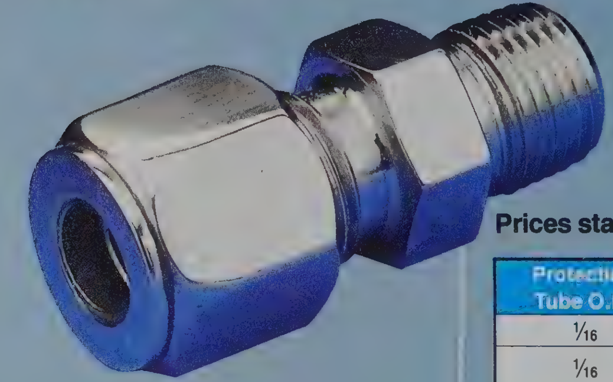
OMEGA Type PR-15 RTD probes are supplied with a color coded nylon terminal block fitted with large pan head screws for secure terminations. PR-15 probes can be used for direct immersion and are easily mounted into fixtures, pipes, tanks and ducts using OMEGALOK™ compression fittings. Use stainless steel ferrules for permanent installations or Teflon ferrules for removable applications.

Model Number	Lead Type	Ohms at 0°C	Sheath Length	Price ¼" O.D.	Price ⅛" O.D.
PR-15-2-100-☐ 5½-E	2	100	5½″	$71	$84
PR-15-2-100-☐ 8½-E	2	100	8½″	71	84
PR-15-2-100-☐ 11½-E	2	100	11½″	71	84
PR-15-2-100-☐ 17½-E	2	100	17½″	75	87
PR-15-2-100-☐ 23½-E	2	100	23½″	78	90

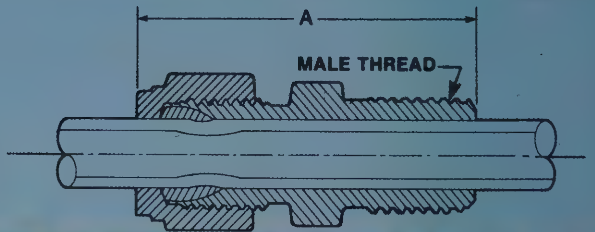
* Replace [ ] with desired diameter, ¼″ or ⅛″.
Refer to Page E-5 for elements other than 100 Ω, α = 0.00385.

**Terminal block is rated for 425°F (218°C)

OMEGALOK™ Compression Fittings



Prices start at $3



OMEGALOK™ Compression Fittings provide an efficient, convenient means of securing and sealing OMEGA thermocouples, RTDs and other probe-type sensors into tanks, chambers and pipes. The ferrule can be applied at any point along the probe's length. The metal ferrule is deformed when the seal is made which is accomplished by tightening up on the cap nut. Because of this, metal ferrules cannot be reused. Replacement ferrules are available—see below. Pressure ratings are up to 5,000 PSIG depending on material, assembly configuration and service temperature.

Protection Tube O.D.	Male Th'd NPT	"A" In.	Brass		316 Stainless Steel	
			Cat. No.	Price	Cat. No.	Price
1⁄16	1⁄16	0.97	N/A	—	SSLK-116-116	$12.25
1⁄16	⅛	1.03	BRLK-116-18	$4.75	SSLK-116-18	12.00
⅛	⅛	1.18	BRLK-18-18	3.00	SSLK-18-18	8.00
⅛	¼	1.74	BRLK-18-14	3.50	SSLK-18-14	8.50
3⁄16	⅛	1.22	BRLK-316-18	3.00	SSLK-316-18	8.00
3⁄16	¼	1.81	BRLK-316-14	3.50	SSLK-316-14	8.50
¼	⅛	1.29	BRLK-14-18	3.00	SSLK-14-18	8.00
¼	¼	1.48	BRLK-14-14	3.00	SSLK-14-14	7.00
5⁄16	¼	1.54	N/A	—	SSLK-516-14	9.00
⅜	¼	1.59	BRLK-38-14	3.50	SSLK-38-14	9.50
⅜	⅜	1.59	BRLK-38-38	4.00	SSLK-38-38	11.00
⅜	½	1.81	BRLK-38-12	5.25	SSLK-38-12	13.50
½	½	1.94	BRLK-12-12	6.00	SSLK-12-12	15.25

Extra and replacement ferrules are available. To order, state protection tube O.D. & material. Price Each—Brass **$1**, Stainless **$3**, Teflon **$4**.

RTD Resistance Temperature Detector

When accuracy over a wide temperature range is a crucial factor in industry, OMEGA's Platinum Resistance Thermometers (RTDs) are unequalled in performance. Stability over long periods of continued use makes them unmatched for reliability. Precision material and workmanship make them highly interchangeable for easy replacement without calibration.

Definition

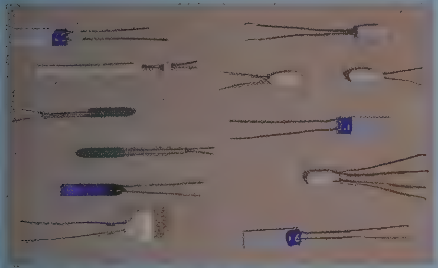
A resistance temperature detector operates on the principle of change in electrical resistance in wire as a function of temperature.

Element or Probe?

A common source of confusion is the distinction between an element and a probe.

The Element

An element is the actual temperature sensing unit. OMEGA features two styles of elements, wire wound and thin film.



PLATINUM RESISTANCE ELEMENTS ALLOWABLE DEVIATION FROM CALIBRATION VALUES

Temperature		Ohms	Deviation Degrees		Temperature		Ohms	Deviation Degrees	
°C	°F		°C	°F	°C	°F		°C	°F
−220	−364	±0.7	±1.8	±3.24	400	752	±0.85	±2.4	±4.32
−200	−328	±0.5	±1.2	±2.16	500	932	±1.0	±3.0	±5.40
−100	−148	±0.3	±0.7	±1.26	600	1112	±1.2	±3.6	±6.48
0	32	±0.1	±0.3	±0.54	700	1292	±1.35	±4.2	±7.56
100	212	±0.25	±0.6	±1.08	750	1382	±1.4	±4.5	±8.10
200	392	±0.45	±1.2	±2.16	800	1472	±1.45	±4.8	±8.64
300	572	±0.65	±1.8	±3.24	850	1562	±1.5	±5.1	±9.18

Wire Wound: The standard RTD elements used in OMEGA's probe assemblies are made of 99.99% pure platinum wire wound about a ceramic or glass core and hermetically sealed within a ceramic or glass capsule. Platinum wire was chosen as it best meets the needs of precision thermometry. It resists contamination, can be highly refined and is mechanically and electrically stable. This provides for close interchangeability between elements with negligible drift and error with age. On special request, OMEGA can make available RTD elements made with other wire materials.

Elements are available conforming to the following two curves:

European (E) α =: 0.00385 ohms/ ohm/ °C

American (A) α =: 0.00392 ohms/ ohm/ °C

Standard OMEGA elements conform to the European (E) curve. Specify an "A" suffix instead of "E" if the American curve is desired on your order. The calibration of all "E" elements meets 0.1% DIN standard tolerance and conforms to the DIN 43 760 Standard, shown in the table. *See curves on page T-34.*

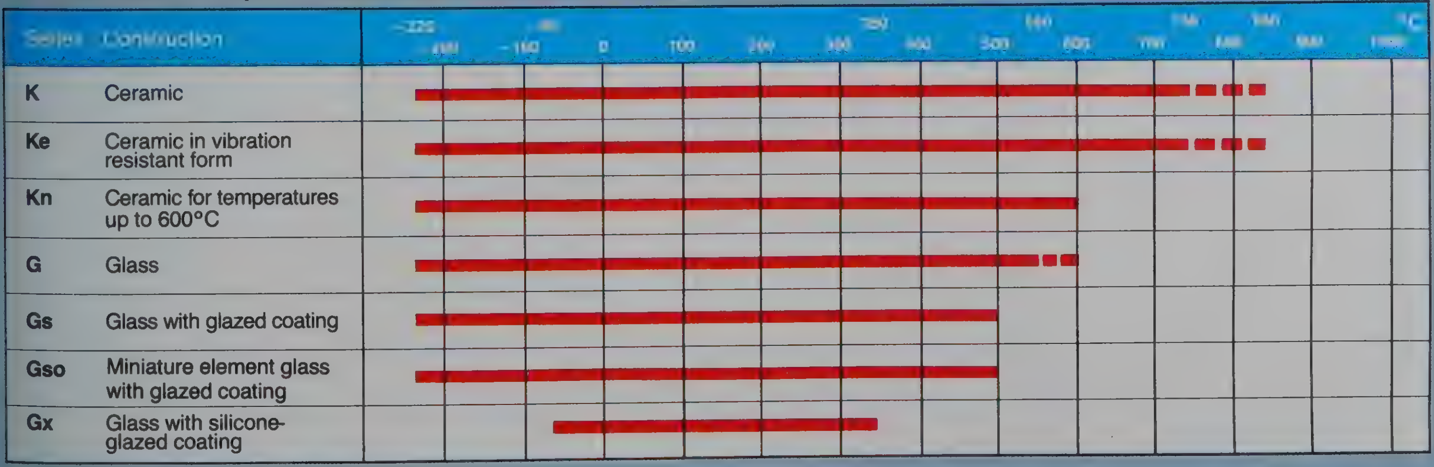
Wire Wound Element Part Numbers

Example: 2 Pt 100 G 30 50

- **2** —2 windings (double resistance element)
- **Pt** —Platinum wire
- **100**—Resistance in ohms at 32°F
- **G** —Glass Core
- **30** —Length of element in mm
- **50** —This value divided by 10 gives element diameter in mm

Thin Film: Made by platinum being deposited as a film on a substrate and then encapsulated. This method allows for the production of small, fast response, accurate sensors. Thin Film elements conform to the European curve/DIN 43 760 standards and the 0.1% DIN standard tolerance.

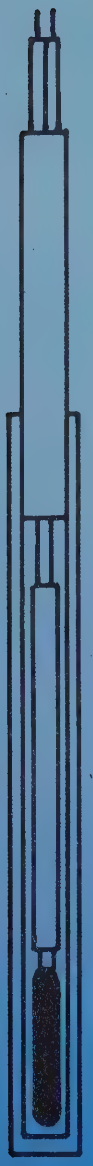
Recommended temperature application ranges—Platinum RTDs



RTD Resistance Temperature Device

The Probe

A probe is an assembly composed of an element, a sheath, lead wire, and a termination or connection.



The termination

Probes may be terminated in a connector head, quick-disconnect, terminal block, or extension wire. OMEGA's standard terminations are pictured on pages E-5 through E-7. Other terminations are available upon special request. Please give a full description and send sketches.

The lead wire

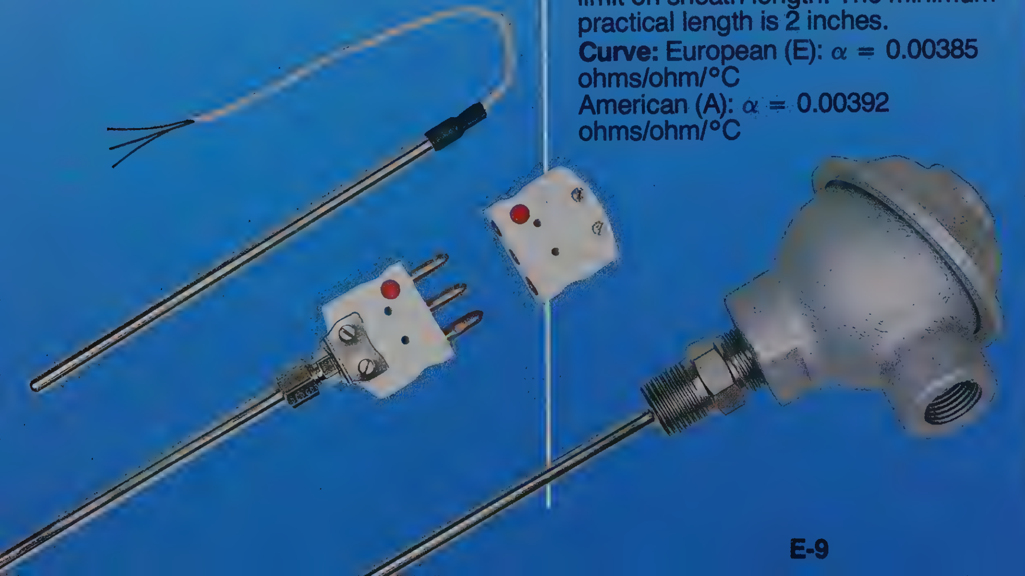
Lead styles are offered in one of four configurations (see diagrams at the side of this page). Style 2 is OMEGA's standard. Be sure to select the configuration that is compatible with your instrumentation.

The sheath

The sheath, a closed end tube, immobilizes the element protecting it against moisture and the environment to be measured. The sheath also provides protection and stability to the transition lead wires from the fragile element wires. OMEGA's standard sheaths are ⅛″ and ¼″ O.D. 304 stainless steel tubes. Other O.D.'s and materials are available upon request.

The element

The element has been described in the previous page. The standard OMEGA RTD probe is made with a 100 ohm European curve element ($\alpha = 0.00385$).

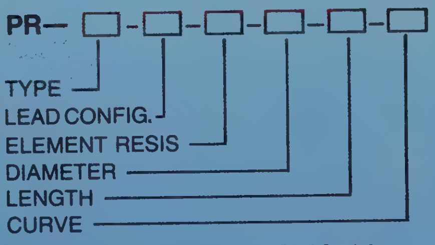


Temperature Rating

OMEGA's Standard RTD probe assemblies are rated for use in temperatures up to 1112°F (600°C). Temperature limitation may be placed on termination styles due to wire insulation used. The maximum temperature rating available on special order is 1382°F (750°C). If probe is intended for high temperature use, please request quotation.

OMEGA stocks a broad line of RTD probes for immediate delivery. Please see pages E-3 through E-7 for standard lengths. Many special assembly probes are available for shipment within two weeks of receipt of your order. Please consult Sales Department for further details on your special needs.

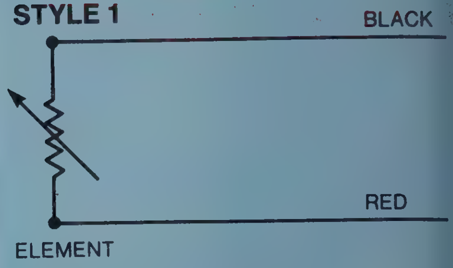
Definition of RTD Probe Part Number



Type: Select style 11, 12, 13, 14, 15 or PRX (pages E-3 through E-7).
Lead Configuration: Specify 1, 2, 3, or 4. Style 2 is standard .
Resistance: 100 ohms is standard. 50, 200, 500, 1000, or 2000 ohms are available, usually with two week delivery.
Sheath Diameter: ⅛″, 3/16″, ¼″, and 5/16″ are available. ⅛″ and ¼″ O.D. probes are stocked for off-the-shelf deliveries.
Sheath Length: There is no upper limit on sheath length. The minimum practical length is 2 inches.
Curve: European (E): $\alpha = 0.00385$ ohms/ohm/°C
American (A): $\alpha = 0.00392$ ohms/ohm/°C

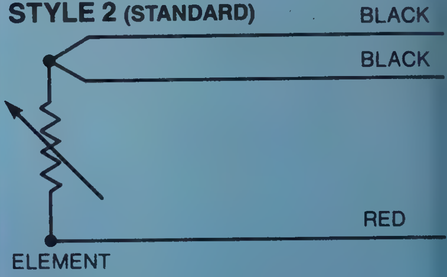
Lead Configurations of RTD Probes

STYLE 1



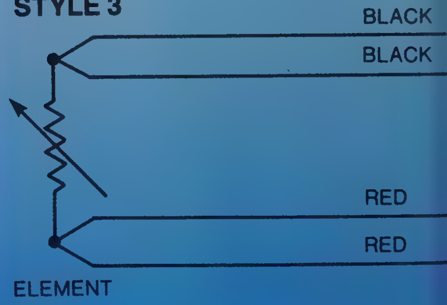
Lead configuration 1 provides one connection to each end of the sensor. This construction is suitable where the resistance of the run of lead wire may be considered as an additive constant in the circuit, and particularly where the changes in lead resistance due to ambient temperature changes may be ignored.

STYLE 2 (STANDARD)



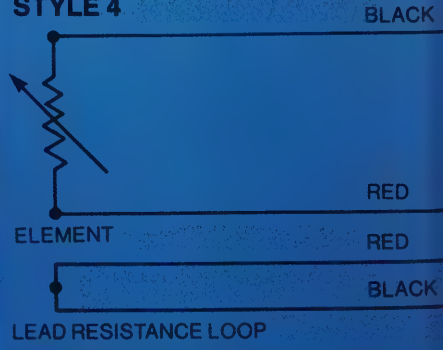
Lead configuration 2 provides one connection to one end and two to the other end of the sensor. Connected to an instrument designed to accept three wire input, compensation is achieved for lead resistance and temperature change in lead resistance. This is the most commonly used configuration.

STYLE 3



Lead configuration 3 provides two connections to each end of the sensor. This construction is used for measurements of the highest precision.

STYLE 4



Lead configuration 4 is similar to Lead Configuration 3 except that a separate pair o wires is provided as a loop to provide compensation for lead resistance and ambient temperature changes in lead resistance.

For Fast Response!
OMEGAFILM RTD Element

Type 100 P 30

The Type P 30 OMEGAFILM element has a very fast response time—up to 50% faster than the same physical size conventional wire-wound element. OMEGAFILM Platinum Resistance Temperature Detectors represent a major advance in precision temperature measurement. In place of the wound coil of wire, OMEGAFILM sensors use a thick film platinum resistive element on an alumina substrate. This construction provides all of the accuracy and reproducibility of wire-wound units while responding much faster to changes in temperature.

Nominal resistance at 0°C is 100 ohms. When used in a sheathed probe construction the operating range is from −220°C to 600°C. These elements in an unsheathed probe in an oxidizing atmosphere can be used in temperatures up to 600°C.

Type 100 P 30 is calibrated to DIN 43760/BS 1904: 1964. Both standards call out an alpha coefficient of 0.00385. Calibration values for DIN 43760/BS 1904: 1964 are shown on Page E-8. Accuracy of these OMEGAFILM sensors are shown in the table below.

Unit price

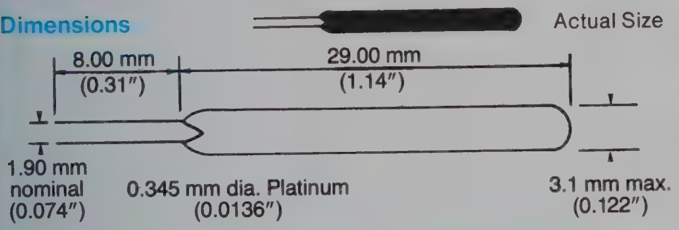
$22

Technical Data

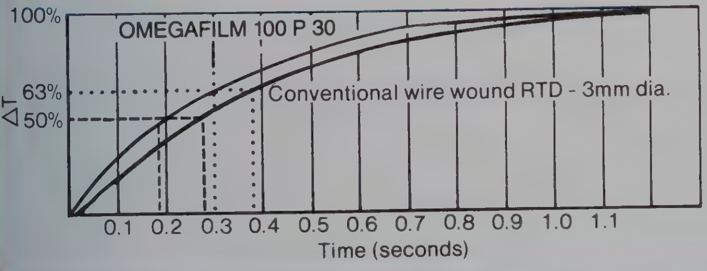
Accuracy of OMEGAFILM, Type 100 P 30, Sensors.

Nominal Temperature (°C)	Temperature Tolerance (Approx.) (±°C)
-50	0.4
0	0.3
100	0.5
200	1.0
300	1.4
400	1.9
500	2.4

Dimensions



Response Time — In Water at 80°C, 1 meter/second

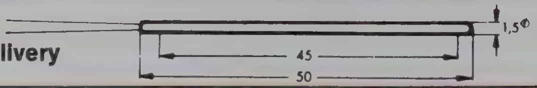
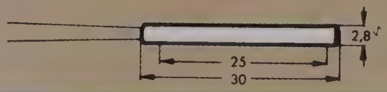
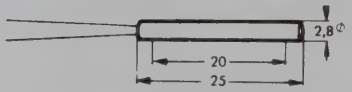
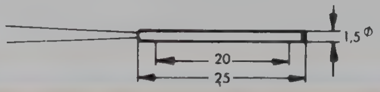
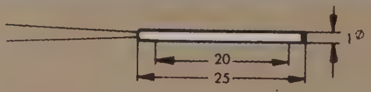
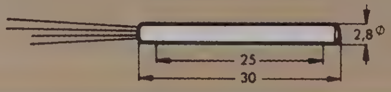
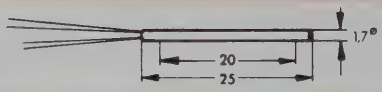
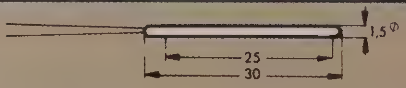
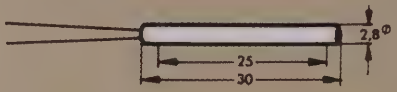
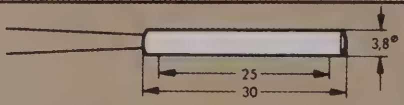
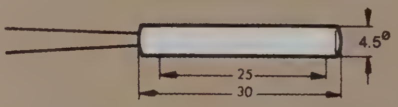
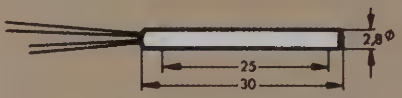
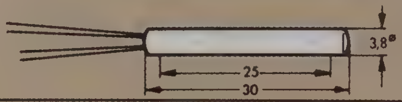
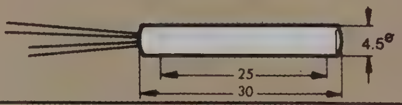
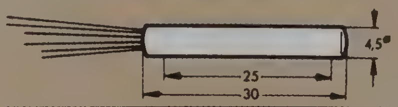


R_0 (ice point resistance)	100 ohms ±0.10 ohm
Fundamental Interval	38.50 ohms (0° to 100°C)
Self Heating	Less than 0.01°C per milliwatt when immersed in well stirred water at the ice point
Temperature Range	−220°C to 600°C
Surface Insulation	>10M ohms at room temperature and 240V or 1M ohms at 600°C and 50V
Capacitance (at 1kHz)	< 10pF
Inductance	< 1μH
Thermal Response (in water, 80°C, 1 meter/second)	<0.3 second to attain 63% of temp. change
Long Term Stability	±0.053% change in R_0 after 2000 hrs at 600°C in air
Stability after Thermal Cycling	±0.02% change in R_0 after 10 cycles between −70°C to +600°C in air
Dimensions	3.1 mm max. dia. × 29 mm long, plus platinum lead wires 0.345 mm dia. × 8 mm long

Discount Schedule

1 to 10 units	**Net**
11 to 24 units	**10%**
25 to 100 units	**12%**
101 to 500 units	**15%**
501 to 1000 units	**17%**

CERAMIC RTD ELEMENTS Platinum Resistance Thermometer

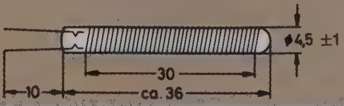
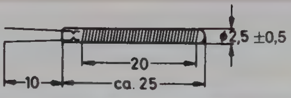
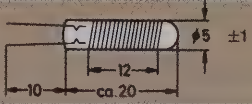
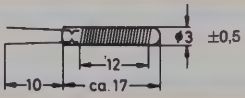
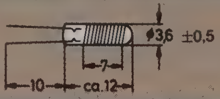
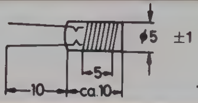
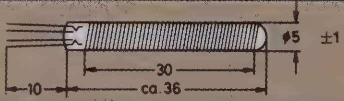
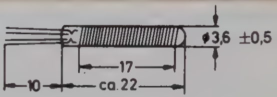
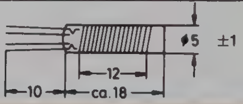
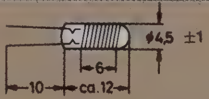
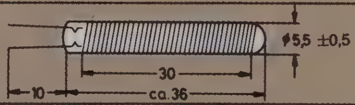
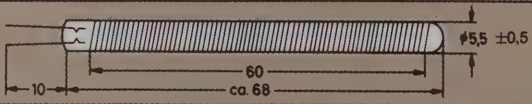
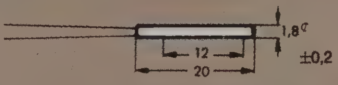
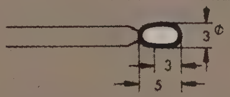
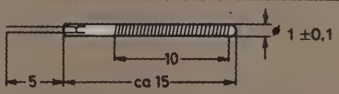
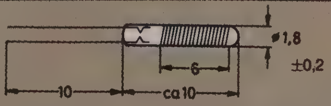
Series	Dimensions (millimeters) 25.4 millimeters = 1.0 inch	Nominal Resis-tance Ohms	Temperature Range °C	**Catalog Number**
K **Ke** **1 Pt 100**	**Stocked for immediate delivery** 	1 × 100	−200 to + 750 intermittently up to 850	**1 Pt 100** **K 45 15**
		1 × 100	−200 to + 750 intermittently up to 850	**1 Pt 100** **Ke 25 28**
	Stocked for immediate delivery 	1 × 100	− 200 to + 750 intermittently up to 850	**1 Pt 100** **K 20 28**
	Stocked for immediate delivery 	1 × 100	− 200 to + 750 intermittently up to 850	**1 Pt 100** **K 20 15**
		1 × 100	−200 to + 750 intermittently up to 850	**1 Pt 100** **K 20 10**
2 Pt 100		2 × 100	− 220 to + 750 intermittently up to 850	**2 Pt 100** **Ke 25 28**
	Stocked for immediate delivery 	2 × 100	−200 to + 750 intermittently up to 850	**2 Pt 100** **K 20 17**
1 Pt 50		1 × 50	−200 to + 750 intermittently up to 850	**1 Pt 50** **K 25 15**
Kn **1 Pt 100**		1 × 100	−200 to + 600	**1 Pt 100** **Kn 25 28**
		1 × 100	−200 to + 600	**1 Pt 100** **Kn 25 38**
		1 × 100	−200 to + 600	**1 Pt 100** **Kn 25 45**
2 Pt 100		2 × 100	−200 to + 600	**2 Pt 100** **Kn 25 28**
		2 × 100	−200 to + 600	**2 Pt 100** **Kn 25 38**
		2 × 100	− 200 to + 600	**2 Pt 100** **Kn 25 45**
3 Pt 100		3 × 100	−200 to + 600	**3 Pt 100** **Kn 25 45**

Discount Schedule

1 to 10 units = NET
11 to 24 units = 10%
25 to 100 units = 12%
101 to 500 units = 15%
501 up = 17%

Price	Self Heating Error in °C/mW		Response Time in Seconds			
	flowing air v = 1 m/s	still air	flowing water v = 0.4 m/s		moving air v = 1 m/s	
			50 % Response	90 % Response	50 % Response	90 % Response
$17	0.06	0.24	0.2	0.6	6.0	20.0
$40	0.07	0.20	0.4	1.2	15.0	50.0
$27	0.12	0.33	0.25	0.7	14.0	50.0
$19	0.08	0.34	0.2	0.6	5.0	18.0
$28	0.02	0.70	0.2	0.6	2.5	9.0
$80	0.07	0.20	0.4	1.2	15.0	50.0
$50	0.08	0.34	0.3	1.0	5.0	18.0
$18	0.05	0.11	0.2	0.6	5.0	18.0
$17	0.06	0.22	0.25	0.7	15.0	50.0
$17	0.06	0.23	0.30	1.1	3.0	120.0
$17	0.06	0.24	0.35	1.4	35.0	125.0
$38	0.06	0.22	0.25	0.7	15.0	50.0
$38	0.06	0.23	0.3	1.1	30.0	120.0
$38	0.06	0.24	0.35	1.4	40.0	140.0
$73	0.06	0.13	0.35	1.4	40.0	140.0

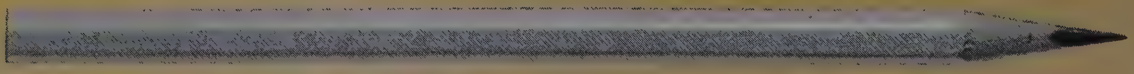
GLASS ENCAPSULATED ELEMENTS Platinum Resistance Thermometer

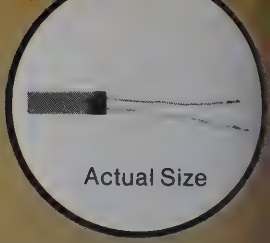
Series	Dimensions (millimeters) 25.4 millimeters = 1.0 inch	Nominal Resistance Ohms	Temperature Range °C	Catalog Number
G Special glass **1 Pt 100**	 ϕ4,5 ±1 30 10 ca. 36	1 × 100	– 220 to + 550 intermittently up to 600	**1 Pt 100 G 30 45**
	Stocked for immediate delivery  ϕ2,5 ±0,5 20 10 ca. 25	1 × 100	– 220 to + 550 intermittently up to 600	**1 Pt 100 G 20 25**
	 ϕ5 ±1 12 10 ca. 20	1 × 100	– 220 to + 550 intermittently up to 600	**1 Pt 100 G 12 50**
	Stocked for immediate delivery  ϕ3 ±0,5 12 10 ca. 17	1 × 100	– 220 to + 550 intermittently up to 600	**1 Pt 100 G 12 30**
	 ϕ3,6 ±0,5 7 10 ca. 12	1 × 100	– 220 to + 550 intermittently up to 600	**1 Pt 100 G 7 36**
	Stocked for immediate delivery  ϕ5 ±1 5 10 ca. 10	1 × 100	– 220 to + 550 intermittently up to 600	**1 Pt 100 G 5 50**
2 Pt 100	 ϕ5 ±1 30 10 ca. 36	2 × 100	– 220 to + 550 intermittently up to 600	**2 Pt 100 G 30 50**
	Stocked for immediate delivery  ϕ3,6 ±0,5 17 10 ca. 22	2 × 100	– 220 to + 550 intermittently up to 600	**2 Pt 100 G 17 36**
	Stocked for immediate delivery  ϕ5 ±1 12 10 ca. 18	2 × 100	– 220 to + 550 intermittently up to 600	**2 Pt 100 G 12 50**
1 Pt 50	 ϕ4,5 ±1 6 10 ca. 12	1 × 50	– 220 to + 550 intermittently up to 600	**1 Pt 50 G 6 45**
1 Pt 500	 ϕ5,5 ±0,5 30 10 ca. 36	1 × 500	– 220 to + 550 intermittently up to 600	**1 Pt 500 G 30 55**
1 Pt 1000	 ϕ5,5 ±0,5 60 10 ca. 68	1 × 1000	– 220 to + 550 intermittently up to 600	**1 Pt 1000 G 60 55**
Gs, Gso Platinum wound on glass, coated with enamel. Not for use in direct contact with liquids or vapors. **1 Pt 100**		1 × 100	– 220 to + 500	**1 Pt 100 Gs 12 18**
		1 × 100	– 220 to + 500	**1 Pt 100 Gso 3 30**
Gsg **1 Pt 100**	 ϕ 1 ±0,1 10 5 ca 15	1 × 100	– 60 to + 350	**1 Pt 100 GX 10 10**
	 ϕ1,8 ±0,2 6 10 ca 10	1 × 100	– 60 to + 350	**1 Pt 100 GX 6 18**

Discount Schedule 1 to 10 units = NET 11 to 24 units = 10% 25 to 100 units = 12%

Price	Self Heating Error in °C/mW		Response Time in Seconds			
	flowing air v = 1 m/s	still air	flowing water v = 0.2 m/s		moving air v = 1 m/s	
			50 % Response	90 % Response	50 % Response	90 % Response
$31	0.04	0.17	0.7	2.0	12.0	38.0
$32	0.07	0.30	0.7	2.0	8.0	22.5
$34	0.06	0.26	0.7	2.5	12.5	31.0
$32	0.11	0.49	0.7	2.0	8.0	28.0
$35	0.12	0.40	1.0	3.0	10.0	33.0
$38	0.12	0.46	0.8	3.0	11.0	34.0
$48	0.02	0.13	0.8	2.5	13.5	40.0
$56	0.07	0.28	0.7	2.5	8.0	28.0
$57	0.05	0.21	0.7	2.5	11.0	38.0
$32	0.02	0.09	1.5	4.6	18.0	56.0
$42	0.17	0.64	1.0	3.0	15.5	52.0
$62	0.04	0.20	1.0	3.5	14.5	45.0
$27	0.11	0.57	0.3	0.9	3.0	12.4
$61	0.26	0.71	0.5	1.5	5.0	15.0
$40	0.36	0.8	0.2	0.4	2.0	7.0
$30	0.33	0.75	0.5	1.8	9.0	30.0

101 to 500 units = 15%   501 up = 17%





Actual Size

New! Thin Film Detector (TFD)

(Magnified 13 Times)

This flat shaped platinum-resistance detector represents the latest development by Omega towards miniaturization of temperature sensing devices. It combines the precision temperature measuring capability of the platinum resistance detector with the small temperature sensing tip and rapid response time of the thermocouple.

An immediate field of application for the TFD is likely in the field of surface temperature measurement.

If required the TFD can be supplied in a moisture-proof encapsulation, the leads can also be protected from moisture with silicone rubber. Order No. TFD-EN.

Rapid response times are achieved with the TFD since . . .

— it possesses a large surface area to volume ratio;

— the temperature sensitive platinum layer is separated from the medium to be measured by a thin ceramic substrate of high thermal conductivity.

This is a particular interest for temperature measurement in gaseous media, such as in wind tunnels and air conditioners.

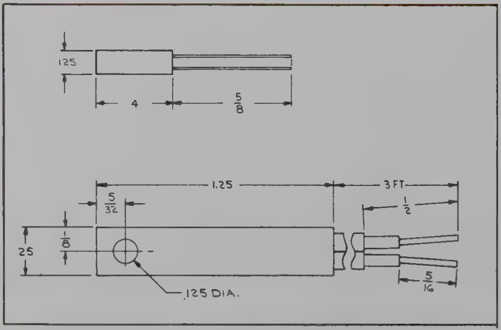
For surface temperature measurements the undersurface of the TFD can be supplied metallized with platinum for soldering purposes. In this way it is possible to devise extremely rapid control systems for use with, for example, electrically heated machines. Order No. TFD-M.

The TFD is also an extremely vibration resistant device.

The resistance values and tolerances comply with DIN 43 760 and BS 1904 (Pt 100 Ω).

To Order:
Specify type TFD and consult factory for price and delivery for special requirements.

Technical Data



Element	TFD Add suffix EN for Moisture-proof encapsulation. Add suffix M for Metallized.
Design	Glass encapsulated platinum layer on a ceramic substrate
Leads	Platinum wire 0.25 mm ϕ, about 20 mm long, on a narrow side
Temperature Range	– 200°C to 500°C
Insulative resistance at 500°C	$>10^8$ ohm
Voltage necessary for destruction	100V (DC)
Hysteresis error (observed only after rapid temperature cycling)	max. 0.25 ohm (can be annealed out)
Self heating error at 20°C	in still air 1.9 mWK^{-1} in still water 75 mWK^{-1}

Part No.	Price	Dimensions
TFD	$25	0.40 × .125 × .030 inches
TFD-M	28	0.40 × .125 × .030 inches
TFD-EN*	55	1.25 × .250 × .250 inches

*Provided with a 24-inch, 2-wire lead.

A Major Advance in RTD Technology!

OMEGA Thinfilm RTD Elements

Features:

Size:	Some as small as thermistors	Accuracy:	Equal to conventional wire-wound units
Shape:	Both flat and cylindrical packages	Response:	Better than equivalent size wire-wound unit
Calibration:	To the worldwide popular DIN 43760 curve	Temperature Range:	To 600°C
		Configuration:	Single and dual with resistance to 2000 ohms

OMEGA introduces the OMEGAFILM platinum RTD element — an element achieved through similar construction techniques used to manufacture miniature electronic integrated circuits. A precision element available in sizes considerably smaller than the head of a match. All this in a rugged, accurate, ceramic encased package! Best of all, the OMEGAFILM elements are calibrated to the worldwide accepted DIN 43760 curve (alpha = 0.00385) allowing use with standard off-the-shelf instrumentation available from OMEGA and others, both in the United States and abroad.

Accuracy and Specifications:

OMEGAFILM platinum RTD's are calibrated to the internationally accepted DIN 43760 curve (alpha = 0.00385) and meet 0.1% DIN standard tolerance. Resistance tables and accuracy tables at specific temperatures are given on Page E-8 . In using these tables please note the specific operating range for elements vary and are listed on the specifications pages, E-17 and E-18.

Applications:

Because of small size and thin, flat packaging, OMEGAFILM sensors greatly extend the field of RTD applications. Series W such as W2103 lends itself to encapsulation in short 1/8″ O.D. protection tubes or shallow holes bored in a metal casing. Series F are ideal for surface measurement. These may be taped, cemented or embedded. For accurate representative measurements, good thermal contact between the surface and the element is important. For temporary installation a compatible temperature rated heat conductive compound, such as a heat sink, grease may be used. A discussion of lead wire configuration is on Page E-8 .

A Major Advance in RTD Technology!

OMEGA® Thinfilm RTD Elements

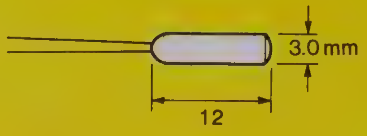
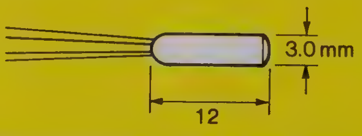
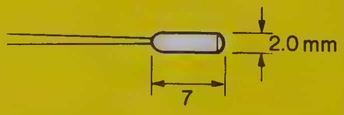
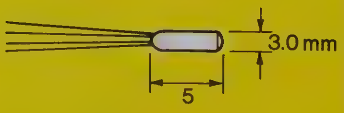
OMEGAFILM RTD's may be used with various OMEGA controllers and digital readout thermometers. The following lists where some of these instruments can be found in this catalog:

	Instrument	Page
a)	Series 49 and 50 Controllers	P-43
b)	Model 199 P1 and P2 Digitals	M-32
c)	Series 400 Digital Meters	M-24

OMEGA can offer Series W and Series F OMEGAFILM RTD's encapsulated in hex head machine screws and other metal holders similar to P/N ON-930, ON-950 and ON-960 shown on Pg. F-6. Please contact OMEGA's Applications Engineering Department about custom assemblies.

OMEGAFILM — Platinum RTD Elements (Alpha = .00385)

Stocked for immediate delivery

Series	Dimensions (mm) 1 mm = .03937"	Single or Dual		Nominal Resistance OHMS	Temperature Range	Catalog Number	Price
W		1	×	100	− 50°C to + 600°C	W2102	$32
		1	×	200		W2112	35
		1	×	400		W2122	39
		1	×	500		W2132	39
		1	×	1000		W2142	48
		1	×	2000		W2152	97
W		2	×	100		W2202	58
		2	×	200		W2212	68
		2	×	400		W2222	66
		2	×	500		W2232	61
		2	×	1000		W2242	71
W		1	×	100		W2103	36
		2	×	100		W2204	64

Series W. Series W are rugged ceramic cylindrically shaped elements for use in the temperature range from −50°C to 600°C. Elements have .015″ gold palladium alloy leads approximately 0.4″ long, which are strain relieved in the stress free ceramic body. Elements are available in both single and dual configurations with resistances at 0°C of 100, 200, 400, 500, 1000 and 2000 ohms. Calibration conforms to standard DIN 43760 with 0.1% resistance tolerance. Resistance vs. Temperature values are shown on Pg. T-71.

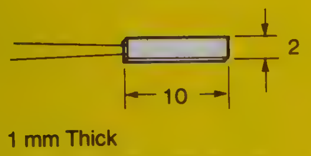
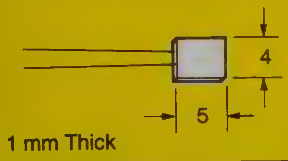
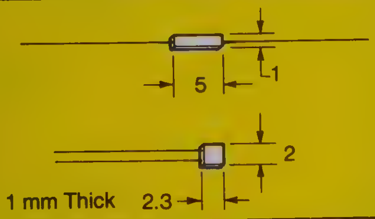
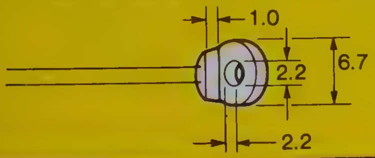
Series F. Series F are small, thin, flat ceramic encased elements with strain relieved silver palladium alloy leads approximately 0.4″ long. Temperature rating is from −50°C to 250°C. Calibration is to DIN standard 43760, 0.1% tolerance. Available in a single winding configuration with a choice of 100, 200, 400, 500 and 1000 ohm resistance at 0°C. Series F elements yield a superior approach to accurate, reliable, surface temperature measurement.

Model WS81. The WS81 donut shaped 100 ohm RTD element offers fast, accurate, temperature measurement as well as a convenient means of attaching it to a surface without cementing. These highly versatile units can be secured to a surface by a machine screw and washer, or by a rivet. They can also be directly cemented with or without the use of a vertical centering post. Rated temperature is from −50°C to 600°C. Accuracy and speed of response are enhanced by locating the winding deposition only 0.007″ beneath the mounting surface. The rugged ceramic body, with firmly strain relieved 0.015″ diameter platinum, is designed to withstand high vibration conditions. This versatile 100 ohm unit meets DIN standard 43760, 0.1% resistance tolerance. Resistance vs Temperature tables are on Pg. T-71.

Discount Schedule
1-10 units . . . . Net
11-24 units 10%

OMEGAFILM — Platinum RTD Elements (Alpha = .00385)

Stocked for immediate delivery

Series	Dimensions (mm) 1 mm = .03937″	Single or Dual	Nominal Resistance OHMS	Temperature Range	Catalog Number	Price
F		1	× 100	−50°C to +250°C	F2101	$19
		1	× 200		F2111	19
		1	× 400		F2121	19
		1	× 500		F2131	19
		1	× 1000		F2141	19
F		1	× 100		F2102	19
		1	× 200		F2112	19
		1	× 400		F2122	19
		1	× 500		F2132	19
		1	× 1000		F2142	19
F		1	× 100		F2104	19
		1	× 100		F2105	19
WS		1	× 100	−50°C to +600°C	WS81	87

F-1

F

Thermistor Probes and Assemblies

400 Series Quick Disconnect Probes F-3
400 Series Laboratory Probes F-4
900 Series Precision Interchangeable Probes F-5
44000 Series Thermistor Elements F-7
Thermistor Applications F-8
700 Series Linear Thermistor Elements F-10
700 Series Laboratory Probes F-13
700 Series Quick Disconnect Probes F-13

Thermistor Probes

Series 400

For use with Heavy Duty HDX Handle

OMEGA
COPPER
COPPER

HDX HANDLE

$35

See page G-3

The OMEGA HDX handle must have an uncompensated OST connector and copper extension cord.

General Purpose Probe

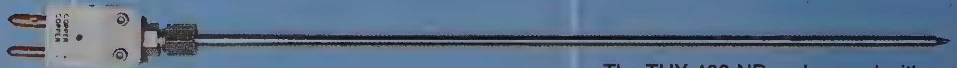
Part Number:
THX-400-GP-12 inch

$70

The THX-400-GP probe used with an HDX handle is ideal for general purpose immersion measurement in gas and liquids. Made from a rugged ⅛″ (3.1 mm) O.D. 304 stainless steel sheath 12″ (304 mm) long, the probe will adapt to most process applications. A high precision 44033 thermistor element is used (2252 Ω @ +25°C) which provides 0.1°C interchangeability and a temperature range of −40° to 212°F (−40° to 100°C).

Penetration Probe

Part Number:
THX-400-NP-12 inch

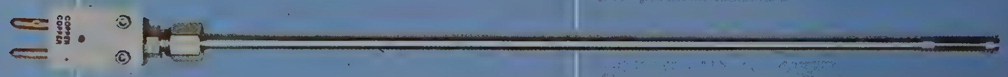


$80

The THX-400-NP probe used with an HDX handle will easily pierce soft and semi-frozen material as well as soil and sand. Made from a rugged 1/8″ (3.1 mm) O.D. 304 stainless steel sheath 12″ (304 mm) long. A high precision 44033 thermistor element is used which provides 0.1°C interchangeability and a temperature range of −40° to 212°F (−40° to 100°C).

Surface Probe

Part Number:
THX-400-SP-12 inch

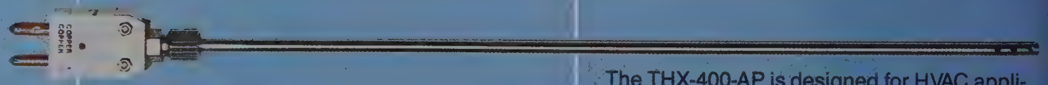


$95

The THX-400-SP is a rugged, fast responding surface probe designed to work with the HDX handle. Made from rugged 3/16″ (4.8 mm) O.D. 304 stainless steel construction, the standard probe has a 12″ (304 mm) length and a custom flexible tip that conforms to most surfaces for accurate repeatable measurements. The 44033 precision element is rated up to 212°F (100°C).

Air Probe

Part Number:
THX-400-AP-12 inch



$90

The THX-400-AP is designed for HVAC applications. The small diameter sheath and radiant energy shield easily fit into duct work, grills and vents. The probe will work with the OMEGA HDX handle or can be permanently mounted using OMEGALOK™ compression fittings. Made from a rugged 3/16″ (4.8 mm) O.D. 304 stainless steel sheath 12″ (304 mm) long, the tip is perforated to expose the thermistor bead to airflow for fast, accurate measurements. The 44033 precision thermistor element is rated up to 212°F (100°C).

SPECIAL ASSEMBLIES AVAILABLE!

Other thermistor elements, sheath lengths and configurations are available upon request. Consult the Sales Department for quotation or send sketch.

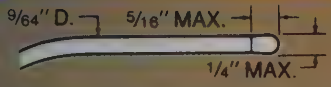
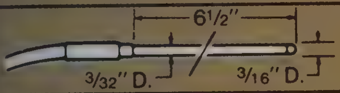
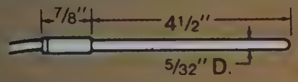
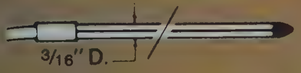
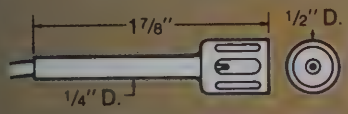
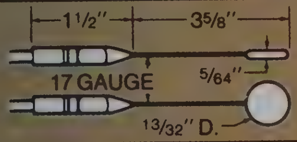
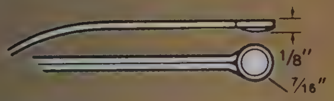
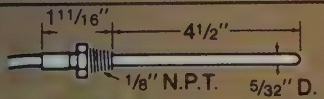
OMEGA "400" Series Thermistor Probes

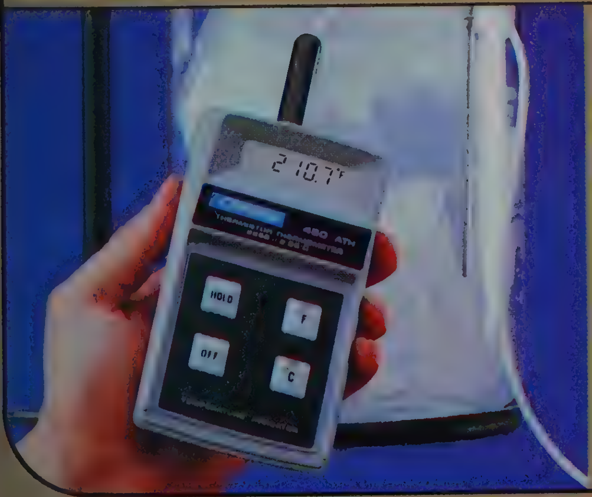
Popular Precision Thermistor Probes for Laboratory Applications

OMEGA ENGINEERING Series "400" probes are for use in laboratory and R&D applications and have interchangeable sensor accuracy of ±0.1°C. Each sensor is supplied with a 10-foot vinyl cable and phone-plug connector. The Series "400" probes are 2252Ω @ 25°C.

Available for "Off-the-Shelf" Delivery

(Price includes phone plug termination and 10 feet of vinyl lead wire.)

Configuration	Model	Description	Temp. Rating	Application	Price
	ON-401-PP	**General Purpose.** Vinyl tipped, most rugged probe. Used for short-term water and sub-soil readings. Waterproof construction available on special order.	212°F 100°C	Buried	$50
	ON-402-PP	**Small Flexible.** Vinyl sheath and tip. Cuvette temperatures. General purpose measurement.	212°F 100°C	General Purpose	$75
	ON-403-PP	**Tubular.** Stainless steel probe for rugged duty. Often used for liquid immersion. Probe is immersible only to cap.	212°F 100°C	Liquid	$70
	ON-404-PP	**Tubular-Glass.** Chemically inert for liquid immersion use. Thermometric titration. Freezing point determination. Pyrex, 5" long.	212°F 100°C	Liquid	$75
	ON-405-PP	**Air Temperature.** Stainless steel probe suitable for test rooms, incubators, remote air readings, monitoring of gas streams, etc.	212°F 100°C	Gas	$70
	ON-408-PP	**"Banjo" Surface Temperature.** Skin, oral, axillary, water bath, air, surface temperatures. Stainless steel.	212°F 100°C	Surface	$106
	ON-409-PP New Dimension	**Attachable Surface Temperature.** Stainless steel cup, epoxy-backed. Easy to tape on flat surfaces. Good for heat loss or compression efficiency study of piping.	212°F 100°C	Surface	$62
	ON-410-PP	**Tubular With Fitting.** Rugged, stainless steel probe with pipe fitting. Suitable for taking readings in pipes or inside closed vessels.	212°F 100°C	Gas Liquid	$70



OMEGA's Series "400" probes recommended for use with:

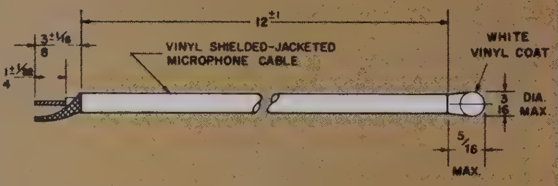
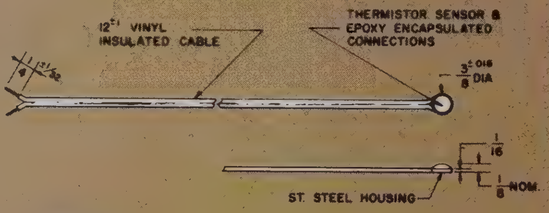
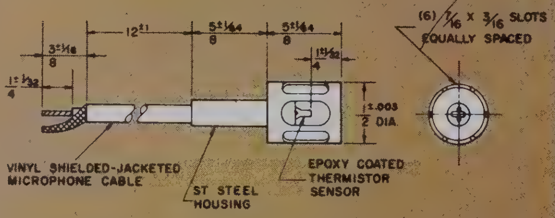
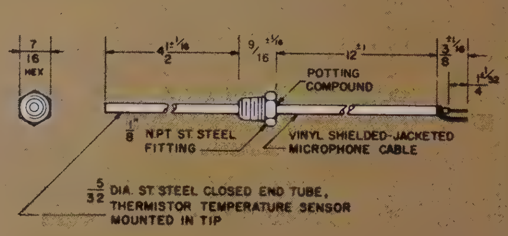
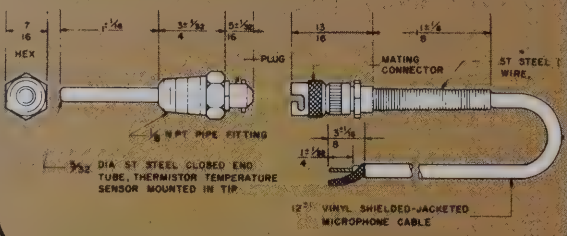
Precision Hand-held Thermometer:

OMEGA Model 450-ATH Precision Thermistor Thermometer. Standard features include °F/°C switchability, 0.1°F/°C resolution, and display hold. Accepts any thermistor probe with a 2252Ω@25°C element. See page C-19.

Series "400" Thermistor Probes are also recommended for use with OMEGA's Thermistor Electronic Panel Meter (Catalog number EP2-32J4) and for OMEGA's Series 49 and 50 Controllers with Option 837. See Page F-7.

Precision-Interchangeable Series

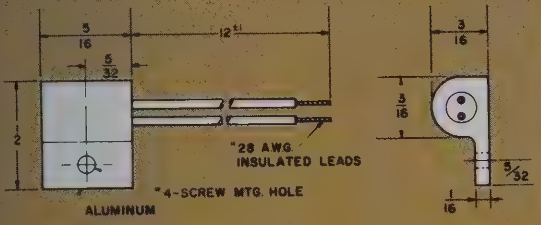
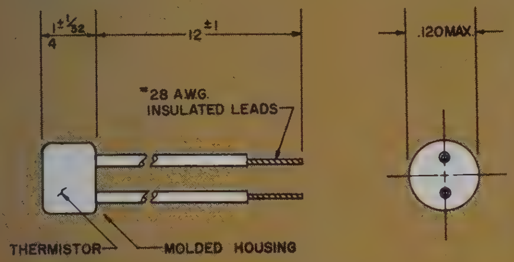
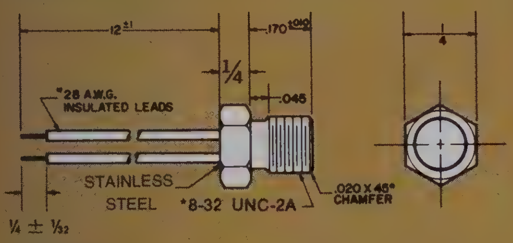
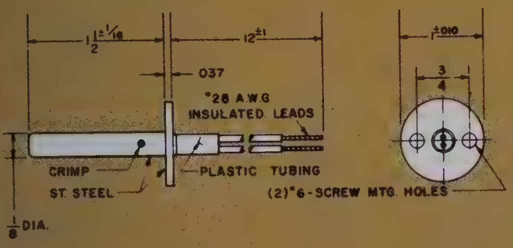
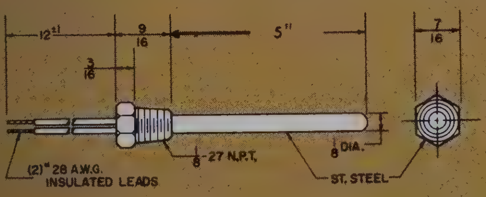
THERMISTORS and Thermistor Probe Assemblies

DIMENSIONS AND MATERIALS	DESCRIPTION AND TYPICAL APPLICATION	CATALOG DESIGNATION	RESISTANCE (ohms) @ 25°C
 12±1 3±1/16 / 8 1±1/32 / 4 VINYL SHIELDED-JACKETED MICROPHONE CABLE WHITE VINYL COAT 3/16 DIA. MAX. 5/16 MAX. **ON-901**	*Vinyl Tip with Shielded-Jacketed Microphone Cable* **Biological:** ideal for animal and biological applications in esophageal or rectal temperature measurement. It is also suitable for use in geographic and oceanographic applications. Design characteristics present an extremely rugged sensor assembly at a minimum cost. Leads: 12″ Maximum temperature: 100°C **Body Type ON-901** **All prices include sensor $36**	ON-901-44004 ON-901-44005 ON-901-44007 ON-901-44006 ON-901-44008	2,252 3,000 5,000 10,000 30,000
 12±1 VINYL INSULATED CABLE THERMISTOR SENSOR & EPOXY ENCAPSULATED CONNECTIONS 1/4±1/32 3/8±.015 DIA 1/16 1/8 NOM. ST. STEEL HOUSING **ON-909**	Epoxy Encapsulated Thermistor Sensor in Stainless Steel Housing with Vinyl insulated leads. **Surface temperature readings:** or control and indication. Ideally suited for applications such as: heat loss or compressor efficiency measurement and control studies of piping systems; determining manifold wall and bearing surface temperatures. Construction facilitates easy attachment to flat surfaces. Leads: 12″ Maximum temperature: 100°C **Body Type ON-909** **All prices include sensor $48**	ON-909-44004 ON-909-44005 ON-909-44007 ON-909-44006 ON-909-44008	2,252 3,000 5,000 10,000 30,000
 12±1 5±1/64 / 8 5±1/64 / 8 3±1/16 / 8 1±1/32 / 4 1±1/32 / 4 1±.003 / 2 DIA. (6) 1/16 x 3/16 SLOTS EQUALLY SPACED VINYL SHIELDED-JACKETED MICROPHONE CABLE ST. STEEL HOUSING EPOXY COATED THERMISTOR SENSOR **ON-905**	Exposed Epoxy Coated Thermistor Sensor mounted in open-end Stainless Steel housing with vinyl shielded Jacketed Microphone cable. **Air temperature measurement, control and indication:** design characteristics offer a perfect sensor assembly for monitoring gas streams. Ideal for temperature measurement and control of remote air readings. Leads: 12″ Maximum temperature: 100°C **Body Type ON-905** **All prices include sensor $55**	ON-905-44004 ON-905-44005 ON-905-44007 ON-905-44006 ON-905-44008	2,252 3,000 5,000 10,000 30,000
 7/16 HEX 4 1±1/8 / 2 9/16 ±1/8 12±1 3±1/16 / 8 1±1/32 / 4 POTTING COMPOUND 1/8 NPT ST. STEEL FITTING VINYL SHIELDED-JACKETED MICROPHONE CABLE 5/32 DIA. ST. STEEL CLOSED END TUBE, THERMISTOR TEMPERATURE SENSOR MOUNTED IN TIP **ON-910**	Closed-End Stainless Steel Tube with Thermistor sensor Mounted in tip. 1/8 N.P.T. fitting with vinyl Shielded-Jacketed Microphone cable. **Liquid immersion sensor assembly:** rugged design and closed-end tube construction. Ideally suited for temperature measurement, control and indication in fluids. Also for use in a wide variety of pressurized systems' applications. Leads: 12″ Maximum temperature: 100°C **Body Type ON-910** **All prices include sensor $55**	ON-910-44004 ON-910-44005 ON-910-44007 ON-910-44006 ON-910-44008	2,252 3,000 5,000 10,000 30,000
 7/16 HEX 1±1/16 3±1/32 / 4 5±1/32 / 16 PLUG 13/16 1±1/8 / 8 MATING CONNECTOR ST. STEEL WIRE 1/8 NPT PIPE FITTING 3±1/16 / 8 1±1/32 / 4 5/32 DIA ST. STEEL CLOSED END TUBE, THERMISTOR TEMPERATURE SENSOR MOUNTED IN TIP 12±1 VINYL SHIELDED-JACKETED MICROPHONE CABLE **ON-920**	Closed-End Stainless Steel tube with Thermistor sensor mounted in tip. 1/8 N.P.T. fitting with vinyl Shielded-Jacketed cable. **Biological:** tubular autoclavable immersion sensor assembly with detachable mating connector. Used in temperature measurement and control of animal apparatus. Also for use in closed vessels with pressurized systems where detachable leads are desirable. Leads: 12″ Maximum temperature: 100°C **Body Type ON-920** **All prices include sensor $83**	ON-920-44004 ON-920-44005 ON-920-44007 ON-920-44006 ON-920-44008	2,252 3,000 5,000 10,000 30,000

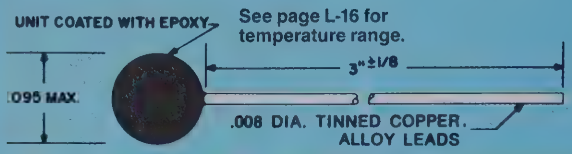
NOTE: **OMEGA's** Precision Interchangeable Probes are normally constructed with ±0.2°C Interchangeable Thermistors. These are Types 44004, 44005, 44007, 44006, and 44008.

If assemblies are required with ±0.1°C Interchangeable Probes, change the portion of the catalog designation to reflect the ±0.1°C Thermistor. Example ON-901-44004 becomes ON-901-44033. Add $11 to the designated catalog price for ±0.1°C Interchangeable Thermistors.

Interchangeable Thermistors with ±0.1°C interchangeability are Types 44033, 44030, 44034, 44031, and 44032.

DIMENSIONS AND MATERIALS	DESCRIPTION AND TYPICAL APPLICATION	CATALOG DESIGNATION	RESISTANCE (ohms) @ 25°C
 5/16 12 ±1 5/32 1/2 3/16 3/16 5/32 1/16 *28 AWG. INSULATED LEADS *4-SCREW MTG. HOLE ALUMINUM **ON-930**	Epoxy Encapsulated Thermistor sensor in screw mounted aluminum housing with Teflon insulated leads. **Surface sensor assembly:** designed for a variety of temperature measurement and control applications. It represents a low cost, fast response unit and lends itself to easy mounting on flat surfaces. Leads: 12″ Maximum temperature: 100°C **Body Type ON-930** **All prices include sensor** **$44**	ON-930-44004	2,252
		ON-930-44005	3,000
		ON-930-44007	5,000
		ON-930-44006	10,000
		ON-930-44008	30,000
 1 ±1/32 / 4 12 ±1 .120MAX. *28 AWG. INSULATED LEADS THERMISTOR MOLDED HOUSING **ON-940**	Encapsulated Thermistor sensor in molded housing with Teflon insulated leads. **Insertion sensor assembly:** specifically designed for high reliability, high volume, and low cost applications where fast time response and small size are determining factors. The unit is easily affixed by inserting in small hole for mounting. Leads: 12″ Maximum temperature: 100°C **Body Type ON-940** **All prices include sensor** **$42**	ON-940-44004	2,252
		ON-940-44005	3,000
		ON-940-44007	5,000
		ON-940-44006	10,000
		ON-940-44008	30,000
 12 ±1 .170 ±.010 1/4 .045 4 *28 A.W.G. INSULATED LEADS STAINLESS STEEL *8-32 UNC-2A .020 X 45° CHAMFER 1/4 ± 1/32 **ON-950**	Stainless steel housing with 1/4″ hex. head and #8-32 NC-2A Threaded Body. Thermistor sensor epoxy encapsulated in housing with Teflon insulated leads. **Surface sensor assembly:** for temperature measurement and control where design problems require stability against vibration and shock. The unit has been designed for temperature control and measurement problems, where low cost and reliability is a proven factor. Leads: 12″ Maximum temperature: 100°C **Body Type ON-950** **All prices include sensor** **$43**	ON-950-44004	2,252
		ON-950-44005	3,000
		ON-950-44007	5,000
		ON-950-44006	10,000
		ON-950-44008	30,000
 1 1/2 ±1/16 12 ±1 .037 1 ±.010 3/4 *28 A.W.G INSULATED LEADS CRIMP ST. STEEL PLASTIC TUBING (2)*6-SCREW MTG. HOLES 1/8 DIA. **ON-960**	Closed-end Stainless Steel tube with thermistor sensor mounted in tip. Stainless steel mounting plate with (2) two mounting holes welded to tube. Teflon insulated leads. **Air flow sensor assembly:** designed to satisfy the many requirements of air temperature measurement and control in Air Conditioning systems and equipment cooling systems. The unit lends itself to easy mounting to standard metal ducting. Leads: 12″ Maximum temperature: 100°C **Body Type ON-960** **All prices include sensor** **$44**	ON-960-44004	2,252
		ON-960-44005	3,000
		ON-960-44007	5,000
		ON-960-44006	10,000
		ON-960-44008	30,000
 12 ±1 9/16 5″ 7/16 3/16 (2)*28 A.W.G. INSULATED LEADS 1/8-27 N.P.T. 1/8 DIA. ST. STEEL **ON-970**	Stainless Steel housing with 7/16 hex. head and 1/8-#27 N.P.T. threaded body. Thermistor sensor epoxy encapsulated in housing with Teflon insulated leads. **Liquid immersion fluid sensor assembly:** ideal for obtaining temperature measurement and control readings in pipes or closed vessels within pressurized systems. Threaded hex. head design affords greater resistance to shock and vibration when mounted. Leads 12″ standard, other lengths available consult factory. Maximum temperature: 100°C **Body Type ON-970** **All prices include sensor** **$55**	ON-970-44004	2,252
		ON-970-44005	3,000
		ON-970-44007	5,000
		ON-970-44006	10,000
		ON-970-44008	30,000

44000 SERIES THERMISTOR ELEMENTS


UNIT COATED WITH EPOXY
See page L-16 for temperature range.
3"±1/8
.095 MAX.
.008 DIA. TINNED COPPER ALLOY LEADS

INDIVIDUAL PRECISION INTERCHANGEABLE SENSORS, AVAILABLE ±0.2°C & ±0.1°C ACCURACY

Epoxy encapsulated, precision matched to standardized resistance temperature curve, providing predicted temperature accuracy based on resistance values and tolerance shown on page F-9.

	PART NO.	RESISTANCE (Ohms) @ 25°C	PRICE EACH 1-9 Units	PRICE EACH 10-24 Units	PRICE EACH 25-99 Units	OVER 100 Units
0.2°C Interchangeability	44004	2,252	$15	$12	$10	CONSULT FACTORY
	44005	3,000	$15	$12	$10	
	44007	5,000	$15	$12	$10	
	44006	10,000	$15	$12	$10	
	44008	30,000	$15	$12	$10	
0.1°C Interchangeability	44033	2,252	$22	$19	$16	
	44030	3,000	$22	$19	$16	
	44034	5,000	$22	$19	$16	
	44031	10,000	$22	$19	$16	
	44032	30,000	$22	$19	$16	

See pages F-4 and F-5 for Interchangeable Thermistor probe assemblies.

Readout Meters & Temperature Controllers for OMEGA Interchangeable Sensors & Probes

0°C
20
40
60
80
100
20°F
60
100
140
180
230
OMEGA ENGINEERING INC STAMFORD, CONN.

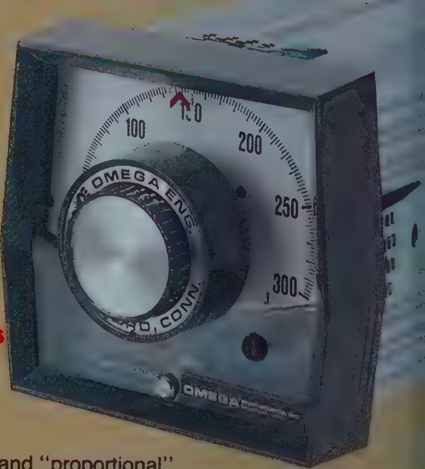
Model EP-2 **$225** (Dimensions same as EP-1 on page L-15)

Thermistor Electronic Readout Meter

This solid state 110 VAC amplifier powered meter is a perfect match for the 44000 series interchangeable thermistor sensors as well as the ON series probes shown on Pages F-5 & F-6.

Ranges	Thermistor	Part No.
−10°C to +110°C and +25°F to +230°F	44004 44005 44007	EP2-32J4 EP2-33J4 EP2-35J3
0°C to 100°C and 32°F to 212°F		EP2-44018

Electronic Readout for OMEGA's Interchangeable Thermistors
See Page P-46 for additional information.


100
150
200
250
300
OMEGA ENG. STAMFORD, CONN.
OMEGA

Model 49 and 50 Series Temperature Controllers

with Option 837

Prices start at **$270**

This versatile series of "on-off" and "proportional" Temperature Controllers, specified with *Option 837*, are specifically designed for use with 44000 series interchangeable sensors and ON series probes, page F-5 & F-6.

The Model 49 and 50 series controllers, with Option 837, are available in the following ranges:

Thermistor Ranges for 44007	
5000 ohms @ 25°C (for use with Option 837 only)	
Range	**°/Div.**
+ 65° to +215°F	1°F
+115° to +215°F	1°F

Thermistor Ranges for 44004	
2252 ohms @ 25°C (for use with Option 837 only)	
Range	**°/Div.**
−90° to + 20°F	1°F
+70° to +220°F	1°F
+10° to + 40°C	.2°C

See pages P-46 through P-52 for additional information.

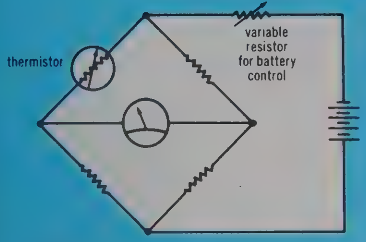

thermistor
variable resistor for battery control

Fig. 1

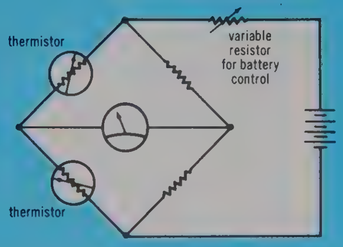

thermistor
variable resistor for battery control
thermistor

Fig. 4

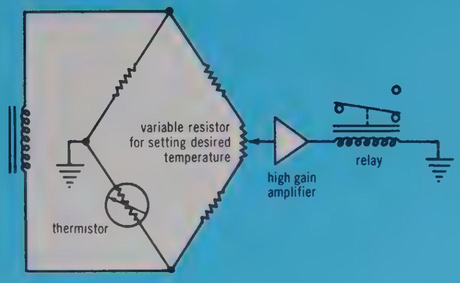

variable resistor for setting desired temperature
thermistor
high gain amplifier
relay

Fig. 6

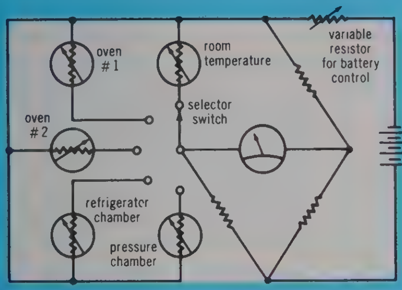

oven #1
room temperature
variable resistor for battery control
oven #2
selector switch
refrigerator chamber
pressure chamber

Fig. 2

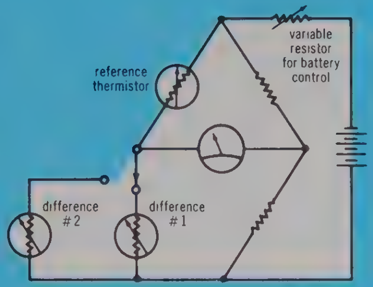

reference thermistor
variable resistor for battery control
difference #2
difference #1

Fig. 5

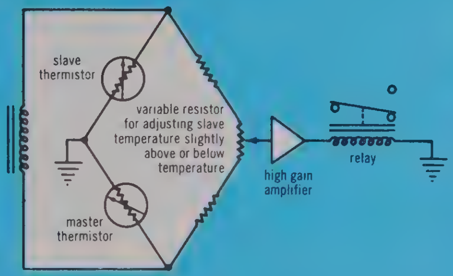

slave thermistor
variable resistor for adjusting slave temperature slightly above or below temperature
master thermistor
high gain amplifier
relay

Fig. 7

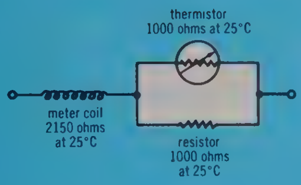

thermistor 1000 ohms at 25°C
meter coil 2150 ohms at 25°C
resistor 1000 ohms at 25°C

Fig. 3

OMEGA® Interchangeable Thermistor Applications—

Thermistors can be used in a variety of ways. Here are a few typical applications. If you have questions concerning these or other thermistor uses, we will be happy to discuss them.

TEMPERATURE MEASUREMENT—A thermistor in one leg of a Wheatstone bridge circuit will provide precise temperature information. Accuracy is limited in most applications only by the readout device. See Figure 1.

Since lead length between thermistor and bridge is not normally a limiting factor, this basic system can be expanded to measure temperature at several locations from a central point. Thermistor interchangeability and large resistance change eliminate any significant error from switches or lead length. See Figure 2.

METER COMPENSATION — The coil resistance of a meter movement changes with temperature, making the meter temperature dependent. Using the thermistor's property of a high negative temperature coefficient, the coil can be compensated so total resistance due to temperature rise is essentially constant, allowing the meter to be used over a wide temperature range with minimal error. See Figure 3.

DIFFERENTIAL THERMOMETERS—For accurate indication of temperature differential, two thermistors can be used in a wheatstone bridge circuit. Thermistor interchangeability simplifies circuit design and reduces the number of components. See Figure 4.

To measure heat loss in a piping network thermistors can be placed at various points and the difference between these temperatures and the original temperature monitored at a convenient location.

Measuring air temperature at different elevations with reference to ground temperature is useful for temperature inversion data and geological studies. See Figure 5.

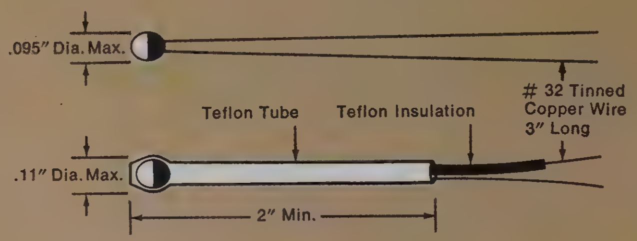
TEMPERATURE CONTROL—A system can be designed using a thermistor with a known temperature/resistance curve to form one leg of an AC bridge and a variable resistor calibrated in temperature to form another leg. When the resistor is set to a desired temperature, bridge unbalance occurs. This unbalance is fed into an amplifier which actuates a relay to provide a source of heat or cold. When the thermistor senses desired temperature, the bridge is balanced, opening the relay and turning off the heat or cold. See Figure 6.

MASTER-SLAVE CONTROL—Occasionally there is a need to control one temperature with respect to another, such as a product going through a series of baths. The first bath acts as a master and uses a thermistor to sense temperature. Succeeding baths, also using thermistors, are slaves. When these thermistors are placed in the controller bridge, the slave baths can be kept at a temperature relative to the master bath.

The master bath can be controlled with the system described earlier. The master-slave controller can be used for as many baths as necessary. See Figure 7.

OMEGA's Precision Interchangeable Thermistors

CONSTRUCTION—Thermistors are manufactured from oxides of nickel, manganese, iron, cobalt, copper, magnesium, titanium, and other metals. All are available epoxy encapsulated, color coded, with two 3″ leads.



Thermistors with 0.2°C interchangeability also are available encased in a 2″ long waterproof Teflon® tube by adding 100 to the part number. For example: 44005 is a standard 3000 Ω thermistor; 44105 is a Teflon encased thermistor with the same temperature/resistance values. Stiff wire is placed in the tube so that with slight finger pressure it can be bent to any configuration.

For Teflon encased thermistors consult the factory.

STABILITY—Finished thermistors are chemically stable and not significantly affected by aging or exposure to strong fields of hard nuclear radiation.

TIME CONSTANT—The time required for a thermistor to indicate 63% of a newly impressed temperature is the time constant. For a thermistor suspended by its leads in a "well stirred" oil bath it is 1 sec. max., or 2.5 sec. max. for Teflon encased thermistors, and in still air it is 10 sec. max., or 25 sec. max. for Teflon units.

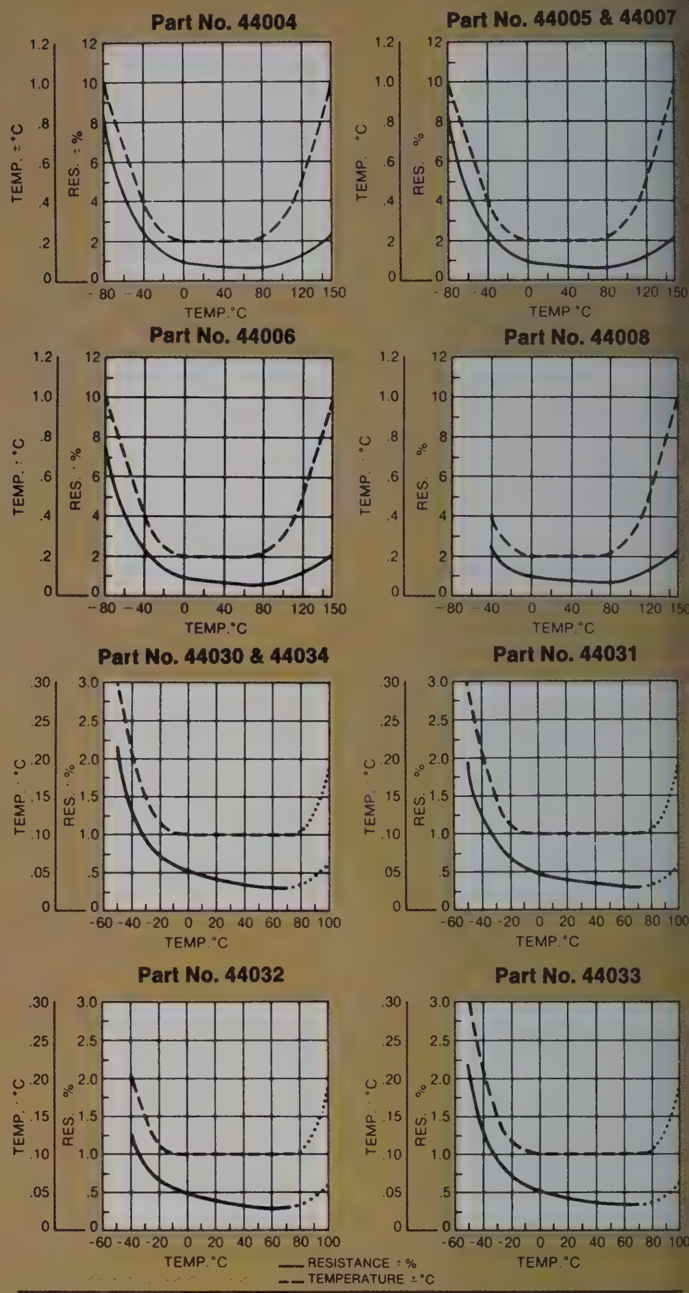
DISSIPATION CONSTANT—The power in milliwatts required to raise a thermistor 1°C above surrounding temperature is the dissipation constant. For all thermistors suspended by their leads in a "well stirred" oil bath it is 8 mw/°C min., or 1 mw/°C min. in still air.

OPERATING TEMPERATURE—Maximum operating temperature is 150°C. Long term stability studies show that extended operation or continued cycling above 90°C will cause thermistors with values less than 2252 ohms at 25°C to eventually exceed tolerances.

Thermistors 44030, 44031, 44032, and 44033 are designed for operation below 75°C. They will operate safely up to 100°C, but extended use above 75°C may cause a change in resistance.

Storage temperature for thermistors is from −80°C to +120°C.

TOLERANCE CURVES—The following curves indicate conformance to standard resistance-temperature values as a % of resistance and as a maximum interchangeability error expressed as temperature.



Thermistor Equation

Occasionally it is advantageous to have a general mathematical expression for a thermistor. Omega finds the following equation best represents thermistor behavio

$$\frac{1}{T} = A + B\,(\mathrm{LOG}_e R) + C(\mathrm{LOG}_e R)^3$$

Where T = °Kelvin; R = resistance; A, B, C = fitting constants.

A, B and C may be found by writing three equations utilizing three known data sets: R1, T1; R2, T2; R3, T3; and solving for A, B and C.

When $-40°C \leq T1, T2, T3 \leq 150°C$ and $| T2 - T1 | \leq 50°C$, $| T3 - T2 | \leq 50°C$ interpolation data generated by this equation will be accurate to ±0.01°C or better.

See Pages F-4 to F-7 for Pricing

Linear Thermistor Components and Probes

OMEGA ENGINEERING, INC. STAMFORD, CONN
-18.3F
thermometer 5800
celsius
fahrenheit
probe
on
30
50°
0
100°
22
122°
32
199°
1
2

Linear Response Components

For applications requiring thermistors with linear response to temperature change, Omega offers linear components. These unique devices consist of a thermistor composite for temperature sensing and an external resistor composite for linearizing.

Thermistor composites 44018 and 44019 each contain two thermistors packaged in a single sensor (Figures 1A & 1B). Thermistor composite 44020 contains three thermistors packaged as a single sensor (Figure 1C).

Resistor composites for use with 44018 and 44019 thermistor composites consist of two metal film resistors of the size shown in Figure 2. Resistor composites for use with the 44020 Thermistor composite consist of three of the same type metal film resistors.

Linear components are manufactured with different values for different temperature ranges. When they are connected in networks shown in Figures 3 and 4, they produce a varying voltage or resistance linear with temperature.

One of the basic network manifestations is a voltage divider as in Figure 3A for components other than #44212, and as shown in Figure 3B for component #44212. The area within the dashed lines represents the thermistor composite. The network hookup for linear resistance versus temperature is shown in Figure 4A for Linear components except #44212 and in Figure 4B for #44212.

Following is a description of why these networks produce linear information. The equation for a voltage divider network, consisting of R and R_0 in series is:

$$E_{out}=E_{in}\,\frac{R}{R+R_0}$$

where Eout is the voltage drop across R. If R is a thermistor, and Eout is plotted versus temperature, the total curve will be essentially non-linear and of a general "S" shape with linear or nearly linear portions near the ends and in the center.

Figure 1A.
Thermistor
Composite 44018

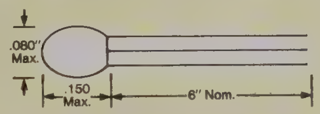

.080″
Max.
.150
Max.
6″ Nom.

Figure 1B.
Thermistor
Composite 44019

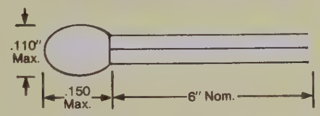

.110″
Max.
.150
Max.
6″ Nom.

Figure 1C.
Thermistor
Composite 44020

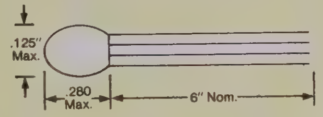
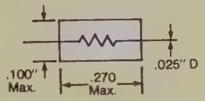

.125″
Max.
.280
Max.
6″ Nom.

Figure 2.
Metal Film
Resistor


.100″
Max.
.270
Max.
.025″ D

If R is modified by the addition of other thermistors and resistors, linearity of the center section of the curve, where sensitivity is greatest, can be extended to cover a wide range of temperatures. This section follows the general equation for a straight line, $Y = mx + b$ or in terms of a linear component:

For Voltage Mode	For Resistance Mode
$E_{out} = \pm MT+b$	$R_t = MT+b$
where M is slope in volts/°T T is temperature in °C or °F b is the value of Eout when $T=0°$	where M is slope in ohms/°T T is temperaure in °C or °F b is the value of the total network resistance, R_t, in ohms when $T = 0°$

Linear Voltage vs. Temperature

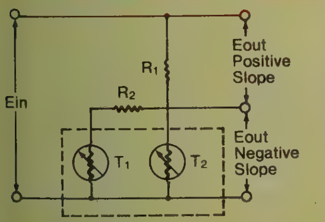

Ein
R_1
R_2
T_1
T_2
Eout
Positive
Slope
Eout
Negative
Slope

Figure 3A

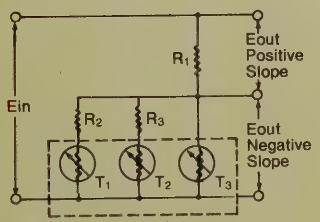

Ein
R_1
R_2
R_3
T_1
T_2
T_3
Eout
Positive
Slope
Eout
Negative
Slope

Figure 3B

Note: Model 5800 includes linearized circuitry

Linear Resistance vs. Temperature

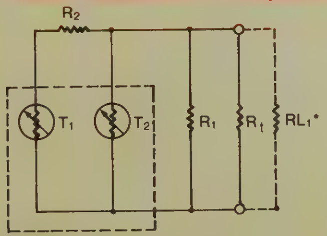

R_2
T_1
T_2
R_1
R_t
RL_1*

Figure 4A

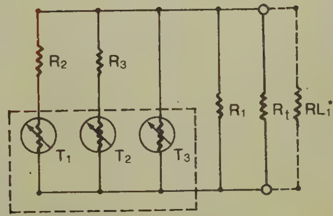
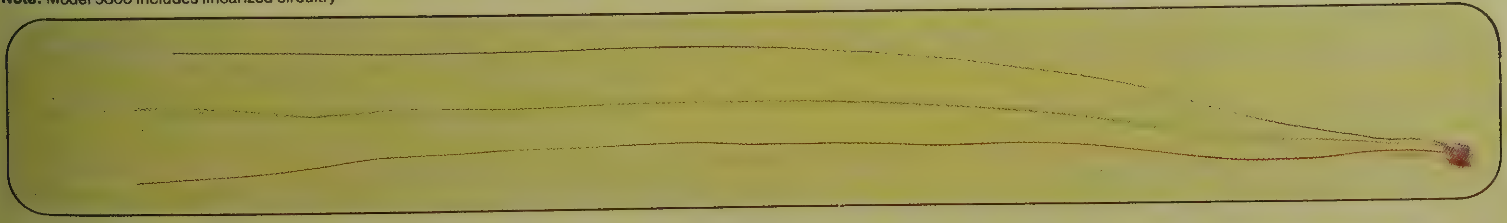

R_2
R_3
T_1
T_2
T_3
R_1
R_t
RL_1*

Figure 4B

*RL_1 may be any value as long as a new R_1 value, (R_{1A}) is selected to satisfy the relationship: $R_{1A}=\frac{R_1 \times RL_1}{RL_1 - R_1}$



Sensitivity is 400 times greater than an IC thermocouple. Thermistor values as high as 30mV/°C are common. In addition, output voltage may be applied to a recorder or digital voltmeter to produce a precise, sensitive, direct reading thermometer.

Multiplexing

The 44018 thermistor composite is used in four of the linear components. The part that changes in each component is the resistor composite, which determines the temperature range. Therefore, the 44018 thermistor composite can be used over the entire −30° to +100°C temperature range by simply changing resistor composites. Its accuracy and interchangeability over the full range is ±0.15°C.

It is not mandatory that Omega resistor composites be used with the 44018 thermistor composite. Any 0.1% resistors of the proper values and with a temperature coefficient of 30 PPM or less may be substituted.

In other situations it is frequently desirable to have thermistor composite temperature sensors at more than one location. When this is required, it is not necessary to have a separate resistor composite for each thermistor composite. It is possible to multiplex any number of thermistor composites through a single resistor composite for greater design flexibility:

Linear Thermistor Components are manufactured under U.S. Patent #3316765 and Canadian Patent #782790.

HOW TO ORDER: Thermistor Elements

Part No.	List Price
44018	$19
44019	$19
44020	$37
44201	$25
44202	$25
44203	$25
44204	$25
44211	$25
44212	$43

Component Specifications

	°C	°F	°C	°F
Linear Components Kit P/N	44201	44201	44202	44202
Range	0° to + 100°C	+32° to +212°F	−5° to +45°C	+23° to +113°F
Thermistor Composite P/N	44018	44018	44018	44018
Resistor Composite Values	R_1 3200 Ω, R_2 6250 Ω	R_1 3200 Ω, R_2 6250Ω	$R_1$5700 Ω, R_2 12,000 Ω	R_1 5700 Ω, R_2 12,000 Ω
Thermistor Accuracy & Interchangeability	±0.15°C −30° to + 100°C	±0.27°F −22° to + 212°F	±0.15°C −30° to +100°C	±0.27°F −22 to +212°F
Eo Positive Slope	Eout = (+0.0053483 Ein) T +0.13493 Ein	Eout = (+0.00297127 Ein) T + 0.03985 Ein	Eout = (+0.0056846 Ein) T + 0.194142 Ein	Eout = (+0.0031581 Ein) T +0.093083 Ein
Eo Negative Slope	Eout = (−0.0053483 Ein) T +0.86507 Ein	Eout = (−0.00297127 Ein) T +0.96015 Ein	Eout = (−0.0056846 Ein) T +0.805858 Ein	Eout = (−0.0031581 Ein) T +0.906917 Ein
Resistance Mode	R_t = (−17.115) T +2768.23	R_t = (−9.508) T +3072.48	R_t = (−32.402) T +4593.39	R_t = (−18,001) T +5169.42
***Ein MAX.**	2.0 VOLTS	2.0 VOLTS	3.5 VOLTS	3.5 VOLTS
***I_T Max.**	625μA	625μA	615μA	615μA
*****Load Res. Min. RL**	3 MEG Ω	3 MEG Ω	10 MEG Ω	10 MEG Ω
Linearity Deviation	±0.216°C	±0.388°F	±0.065°C	±.12°F
Linear Components Kit P/N	44203	44203	44204	44204
Range	−30° to +50°C	−22° to +122°F	−2°C to 38°C	+30° to +100°F
Thermistor Composite P/N	44018	44018	44018	44018
Resistor Composite Values	R_1 18,700 Ω, R_2 35,250 Ω	R_1 18,700 Ω, R_2 35,250 Ω	$R_1$5700 Ω, $R_2$12,400 Ω	R_1 5700 Ω, R_2 12,400 Ω
Thermistor Accuracy & Interchangeability	±0.15°C −30° to +100°C	±0.27°F −22° to +212°F	±0.15°C −2°C to + 38°C	±0.27°F −22 to +212°F
Eo Positive Slope	Eout = (+0.0067966 Ein) T +0.34893 Ein	Eout = (+0.00377588 Ein) T +0.228102 Ein	Eout = (+0.00563179 Ein) T +0.192439 Ein	Eout = (+0.0031289 Ein) T +0.09232 Ein
Eo Negative Slope	Eout = (−0.0067966 Ein) T +0.65107 Ein	Eout = (−0.00377588 Ein) T +0.771898 Ein	Eout = (−0.00563179 Ein) T +0.807563 Ein	Eout = (−0.0031289 Ein) T +0.90768 Ein
Resistance Mode	R_t = (−127.096) T +12175	R_t = (−70.608) T +14435	R_t = (−32.1012)T +4603.1	R_t = (−17.834) T +5173.8
***Ein MAX.**	3.0 VOLTS	3.0 VOLTS	4.0 volts	4.0 VOLTS
***I_T MAX.**	475μA	475μA	685μA	685μA
*****Load Res. Min. RL**	10 MEG Ω	10 MEG Ω	10 MEG Ω	10 MEG Ω
Linearity Deviation	±0.16°C	±0.29°F	±0.03°C	±0.055°F
Linear Components Kit P/N	44211A	44211	44212	44212
Range	−55° to +85°C	−67° to +185°F	−50° to +50°C	−58° to +122°F
Thermistor Composite P/N	44019	44019	44020	44020
Resistor Composite Values	R_1 3550 Ω, $R_2$6025Ω	$R_1$3550Ω, $R_2$6025Ω	$R_1$23,100 Ω, R_2 88,200 Ω R_3 38,000 Ω	R_1 23,100 Ω, R_2 88,200 Ω R_3 38,000 Ω
Thermistor Accuracy & Interchangeability	±0.4°C 0 to +85°C ±0.8°C 0 to −55°C	±.72°F to 185°F ±1.44°F to −67°F	±0.1°C −50° to +50°C	±.18°F −58 to +122°F
Eo Positive Slope	Eout = (+0.005068 Ein) T +0.3411 Ein	Eout = (+0.002816 Ein) T +0.2510 Ein	E out = (+0.00559149 Ein) T +0.40700 Ein	Eout = (+0.00310638 Ein) T +0.30760 Ein
Eo Negative Slope	Eout = (−0.005068 Ein) T +0.6589 Ein	Eout = (−0.002816 Ein) T +0.7490 Ein	Eout = (−0.00559149 Ein) T +0.59300 Ein	Eout = (−0.00310638 Ein) T +0.69240 Ein
Resistance Mode	R_t = (−17.99) T +2339	R_t = (−9.994) T +2658.8	R_t = (−129.163) T +13698.23	R_t = (−71.757) T +15994.5
Ein Max.	2.0 VOLTS	2.0 VOLTS	3.5 VOLTS	3.5 VOLTS
I_T MAX.	833μA	833μA	700μA	700μA
*****Load Res. Min. RL**	10 MEG Ω	10 MEG Ω	10 MEG Ω	10 MEG Ω
Linearity Deviation	±1.1°C	±2°F	±0.15°C (Condition "A")** ±0.08°C (Condition "B")**	±.27°F (A) ±.15°F (B)

*Ein Max and I_T Max values have been assigned to control the thermistor self-heating errors so that they do not enlarge the component error band; i.e., the sum of the linearity deviation plus the probe tolerances. The values were assigned using a thermistor dissipation constant of 8MW/°C in stirred oil. If better heat-sink methods are used or if an enlargement of the error band is acceptable, Ein Max and I_T Max values may be exceeded without damage to the thermistor probe.

**The maximum error at any point is the algebraic sum of the thermistor manufacturing tolerances, plus linearity deviation, a fixed network behavior. Condition "A" is the worst case linearity deviation of ±0.15°C and may occur with the ±0.1% resistors supplied. Condition "B" exists when the three resistors are within ±0.02% of nominal, which reduces linearity deviation to ±0.08°C.

***See Figure 3, F-12

NOTE: The time required for a thermistor composite to indicate 63% of a newly impressed temperature is 1 second in "well stirred" oil and 10 seconds in free, still air.

Typical Linear Component Applications

Example:
To measure and record on a 100MV recorder temperature in the range 30° to 40°C:

1 Select Part #44202 (Temperature range −5° to +45°C)
basic equation $E_{out_1} = (-0.0056846\,E_{in})\,T + 0.805858\,E_{in}$

2 Calculate E_{in} for 10°C equal to 100MV

$$(E_{out_1}\ @30°C - E_{out_1}\ @40°C) = 100MV$$
$$[(-0.0056846\,E_{in})\,30°C + 0.805858\,E_{in}] - [(-0.0056846\,E_{in})\,40°C + 0.805858\,E_{in}] = 100MV$$
$$0.056846\,E_{in} = 100MV$$
$$E_{in} = 1.7591 \text{ Volts}$$

3 Using the Linear network as two legs of a Wheatstone bridge add the two additional legs, R_3 and R_4 so that $E_{out_2} = 0$ when $T = 30°C$. (See Figure 3.) R_3 and R_4 are calculated from five known conditions.

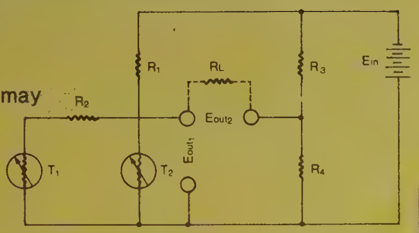
(1) The voltage drop across R_4 (E_{R_4}) should equal E_{out_1} at 30°C for E_{out_2} to equal zero.
(2) $E_{in} = 1.7591$ Volts
(3) 1000 ohms $\le R_3 + R_4 \le$ 5000 ohms. (If $R_3 + R_4$ is less than 1K excessive battery drain may occur. If $R_3 + R_4$ is more than 5K some degradation of linearity will occur).
(4) $E_{R_4} = E_{in}\dfrac{R_4}{R_3 + R_4}$
(5) $E_{out_1} = -0.0056846\,(1.7591 \text{ Volts})\,(+30°C) + 0.805858\,(1.7591 \text{ Volts}) = 1.1180$ Volts

$E_{R_4} = E_{out_1} = E_{in}\dfrac{R_4}{R_3+R_4}$ or $1.1180 = \dfrac{R_4\,1.7591}{R_3+R_4}$ and let us choose $R_3 + R_4 = 1000$ ohms

solve for R_3 and R_4 $\quad 1.1180 = \dfrac{R_4\,1.7591}{R_4 + 1000 - R_4}$ $\quad R_4 = 635.55$ ohms $\quad R_3 = 364.45$ ohms

4 Apply E_{out_2} to the recorder input terminals and the result is a direct reading 10°C full scale thermometer.

Fig. 3



Example:
To make a 4 digit 100MV sensitivity digital voltmeter into a direct reading differential thermometer whose ambient range is −30° to +40°C:

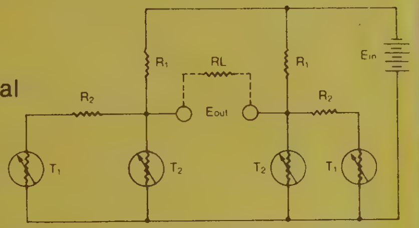
1 Select Part #44203 (Temperature range −30° to +50°C),
basic equation $E_{out} = (-0.0067966\,E_{in})\,T + 0.65107\,E_{in}$

2 Calculate E_{in} so that 10MV equals one degree C. (This is done so that the D.V.M. will read directly in temperature with 0.01°C readability.)

$$(E_{out}\ @ -30 - E_{out}\ @ +40) = 0.700 \text{ Volts}$$
$$[(-0.0067966\,E_{in})\,(-30) + 0.65107\,E_{in}] - [(-0.0067966\,E_{in})(40) + 0.65107\,E_{in}] = 0.700 \text{ Volts}$$
$$0.47576\,E_{in} = 0.700$$
$$E_{in} = 1.4713 \text{ Volts}$$

3 Connect two Linear networks (#44203) as shown in Fig. 4
4 Apply Eout to the D.V.M. input terminals for a direct reading differential thermometer.

Fig. 4



Example:
To make a 2-wire system from a 3-wire system using any Linear component:

1 For the voltage mode, connect R_2 to the thermistor composite. (See Figures 1 & 5.) This unit can function as the temperature sensor and be located remote from the signal conditioning circuit by up to distance "D."
2 The resistance mode differs from the voltage mode only by removal of the power source. (See Figure 6.)
3 Acceptable distance "D" varies according to the temperature range. Using #22 wire "D" may be as follows without loss of accuracy in both 2-wire and 3-wire systems. Where distance "D" is greater than indicated, heavier gauge wire may be used.

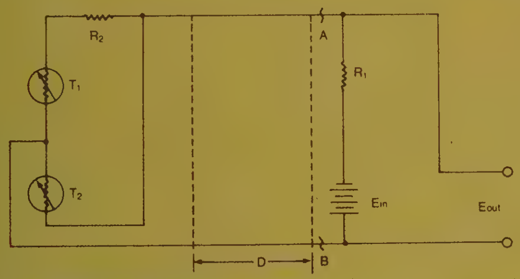


Fig. 5 Voltage Mode

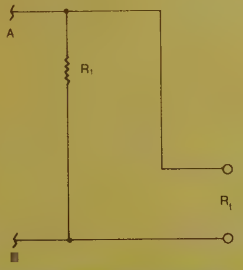


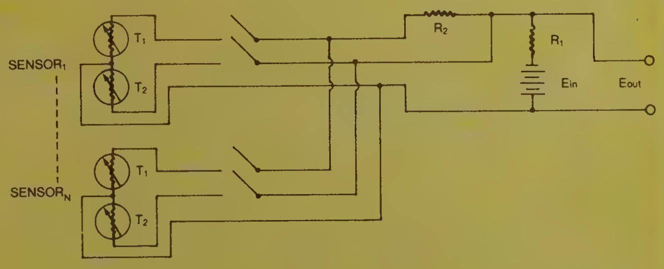
Fig. 6 Resistance Mode

Temperature Range	Distance "D"
0° to +100°C	100′
− 5° to + 45°C	300′
−30° to + 50°C	300′
+30° to +100°F	300′

Example:
Multiplexing to connect any number of thermistor composites to a single signal conditioning circuit.

(See Figure 7). Multiplexing can be accomplished much more easily with a two-wire system, such as shown in Figure 5.

Fig. 7



Thermistor Probes

Series 700 Linear

Series 700 Linear Response probe assemblies are fitted with precision 44018 linear thermistor elements rated to 212°F (100°C). Each is supplied with 10 feet of vinyl covered lead wire. A three (3) conductor phone plug is standard termination. For longer leads, place an "x" after part number and specify length up to 250 feet. Additional lead lengths are available at 80¢ per foot. See Sections C and M for readout instruments.

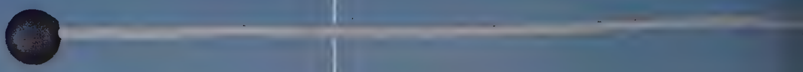
LABORATORY

OL-701-PP General Purpose Vinyl tipped. Often buried for sub-soil readings.

$54

OL-709-PP Attachable Surface Temperature Stainless steel cup, epoxy backed. Easy to tape on flat surfaces.

$63



OL-705-PP Air Temperature Stainless steel probe suitable for test rooms, incubators, remote air readings.

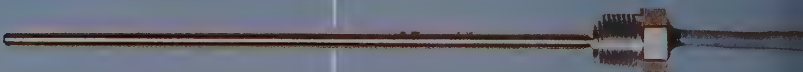
$73

OL-703-PP Tubular Stainless steel probe for rugged duty. Often used for liquid immersion. Immersible only to transition fitting.

$70

OL-710-PP Tubular with Fitting Rugged stainless steel probe with pipe fitting. Suitable for use in pipes or closed vessels.

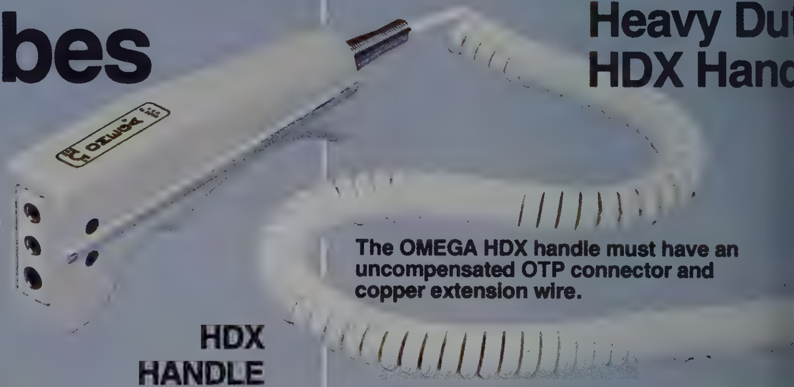
$75



Thermistor Probes

THX-700 probes are designed to work with the heavy duty HDX handle. Each probe has a 3-prong OTP-copper connector termination and precision 44018 linear thermistor element, rated up to 212°F (100°C), which will work with all readout instruments in Sections C and M designed for Series 700 probes.

For use w
Heavy Du
HDX Hanc



Heavy Duty HDX handle

The OMEGA HDX handle must have an uncompensated OTP connector and copper extension wire.

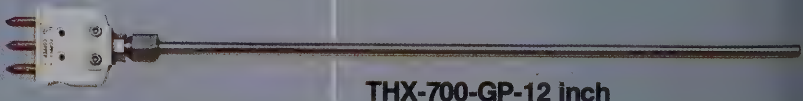
HDX HANDLE

See page G-3 **$35**

QUICK DISCONNECT

General Purpose Probe For general purpose gas and liquid immersion measurements. Made from a rugged ⅛″ (3.1 mm) O.D. 304 stainless steel sheath, 12″ (304 mm) long, it will adapt to most process applications.

$70



THX-700-GP-12 inch

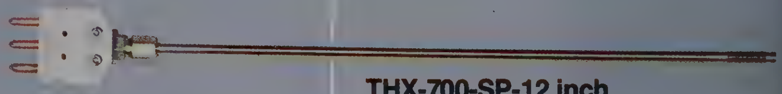
Penetration Probe Easily pierces soft and semi-frozen material as well as soil and sand. Made from a rugged ⅛″ (3.1 mm) O.D. 304 stainless steel sheath, 12″ (304 mm) long.

$80

THX-700-NP-12 inch

Surface Probe Rugged, fast responding surface probe designed to work with the HDX handle. Made from rugged ¼″ (6.3 mm) O.D. 304 stainless steel sheath. The standard length is 12″ (304 mm) and the custom flexible tip conforms to most surfaces for accurate repeatable measurements.

$95



THX-700-SP-12 inch

Air Probe For HVAC applications. The small diameter sheath and radiation hood easily fit into duct-work, grills, and vents. The probe will work with the OMEGA HDX handle or can be permanently mounted using OMEGALOK™ compression fittings.

$90

THX-700-AP-12 inch

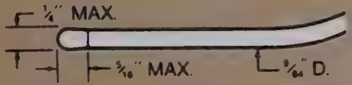
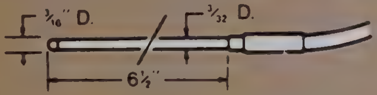
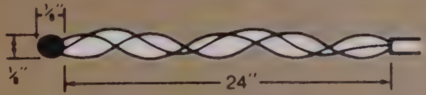
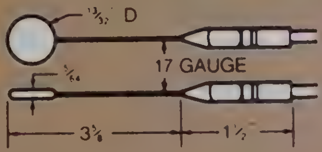
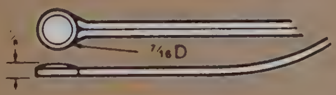
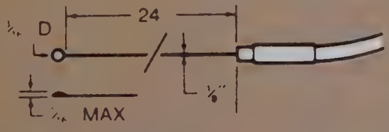
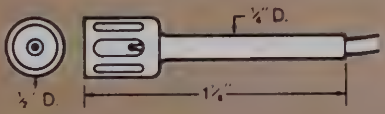
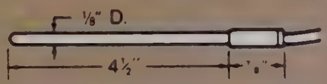
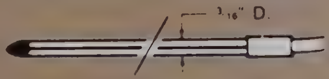
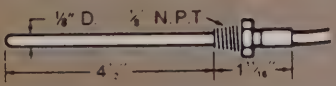
CUSTOM ASSEMBLIES AVAILABLE!

Series 700 probes are available with other elements for different ranges and in other lengths and configurations. Contact the Sales Department or send sketch for quotation.

Linear Response Probes

Series 700 Temperature Probes use the 44018 thermistor composite as the temperature sensor. On special order, probes also can be built with 44019 thermistor composite.

The purpose of the Series 700 Probes is to provide a complete probe assembly for use with the circuits described on page F-10 when it is inconvenient to use the bare 44018 or 44019A thermistor composite.

Probe No.	Description	Configuration	Price
OL-701	GENERAL PURPOSE. Vinyl tipped, most rugged probe. Used for short-term water and sub-soil readings. Waterproof construction now standard.		**$47**
OL-702	SMALL FLEXIBLE. Vinyl sheath and tip. Cuvette temperatures. General purpose measurement.		**$74**
OL-731	GENERAL PURPOSE. Non-immersible, epoxy tipped probe. Can be potted in place. Probe is suitable for temperature measurements on surfaces.		**$62**
OL-708	"BANJO" SURFACE TEMPERATURE. Skin, oral, axillary, water bath, air, surface temperatures. Stainless steel.		**$110**
OL-709	ATTACHABLE SURFACE TEMPERATURE. Stainless steel cup, epoxy backed. Easy to tape on flat surfaces. Good for heat loss or compression efficiency study of piping.		**$56**
OL-729	SMALL SURFACE TEMPERATURE. Cuvette, water bath, leaf and other surfaces. 24" Teflon-covered flexible wire. Stainless steel disc with epoxy back.		**$88**
OL-705	AIR TEMPERATURE. Stainless steel probe suitable for test rooms, incubators, remote air readings, monitoring of gas streams, etc.		**$66**
OL-703	TUBULAR. Stainless steel probe for rugged duty. Often used for liquid immersion. Probe is immersible only to cap.		**$63**
OL-704	TUBULAR-GLASS. Chemically inert for liquid immersion use. Thermometric titration. Freezing point determination. Pyrex, 5" long.		**$74**
OL-710	TUBULAR WITH FITTING. Rugged, stainless steel probe with pipe fitting. Suitable for taking readings in pipes or inside closed vessels.		**$68**

Probe Leads Non-detachable 10' vinyl covered shielded wire with stripped leads. Lead wire may be subjected to 100°C (212°F). Moisture resistant junction between probe and lead wire, except for 702, 709, and 731. For longer leads, place an "X" after part number and specify length up to 250'. Add $.80 per foot for additional length over 10 feet.

700 Series Probes are compatible with OMEGA's 5800-2 (Pages M-56 and M-57), 400 THC and THF (Page M-27) Digital Thermometers, Model 700 Hand-Held Thermometer (Page C-24) and Model 747 Differential Thermometer (Pages M-54 and M-55). When ordering probes for use with 5800-2, 700 and 747 instruments, call out with phone plug and add "PP" as a suffix to part number and add $7 to price.

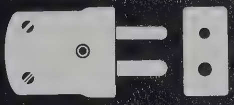
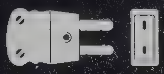
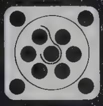
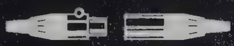
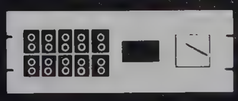
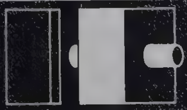
NEW! Multi-pin Connectors with Thermocouple Alloy Pins

OMEGA
OMEGA ENGINEERING INC
COPPER CONSTANTAN
CHROMEL ALUMEL
IRON CONSTANTAN
COPPER COPPER

NEW
LOW
PRICES

G

Thermocouple Connector and Panel Systems

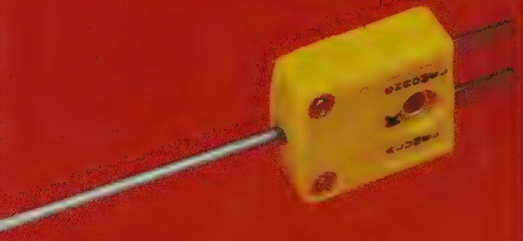
Heavy Duty Connector Handles with Leads		G-3
Standard Size Thermocouple Connectors		G-7
Miniature Size Thermocouple Connectors		G-13
Multi Pin Thermocouple Jacks and Thermocouple Pins		G-15
Round Hole Panel Jacks		G-17
Bezel Strip Mounting for SMP Connectors		G-18
Rectangular Panel Jacks		G-20
Round Terminal Blocks and Protection Heads		G-24, G-35
"T" Series Miniature Connectors		G-25
Two and Three Pole Switches		G-27
Jack Panel Conduit Box		G-29
Spade Lugs, Terminal Lugs and Barrier Strips		G-31
Multiconductor Feedthroughs		G-37
Jack Panels and Assemblies		G-40
Hole Saws and Panel Punches		G-50

Probe Handles

Heavy Duty

Model HDX

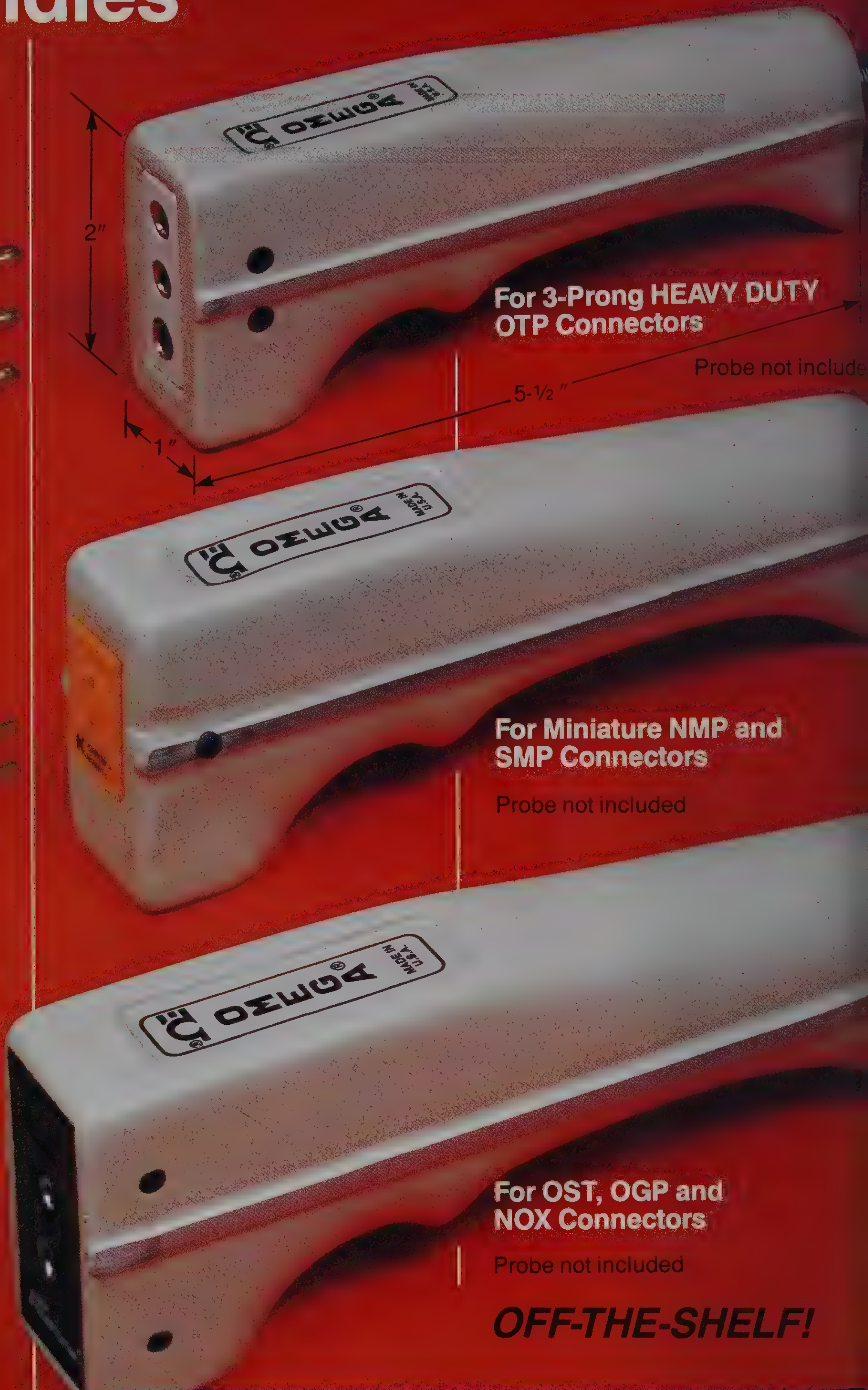
- Strain Relieved
- RSC Retractile Cords
- Cast Aluminum
- Compensated
- ANSI Calibrations



- Accepts:
  Quick Disconnect T/C's
  Series 400 Thermistors
  Linear Thermistor Probes
  PR-13 RTD Probes
- Comfortable Feel

J IRON CONSTANTAN

DISCOUNT	
1-10	Net
11-24	5%
25 up	10%



For 3-Prong HEAVY DUTY OTP Connectors

Probe not include

For Miniature NMP and SMP Connectors

Probe not included

For OST, OGP and NOX Connectors

Probe not included

OFF-THE-SHELF!

HOW TO ORDER

Specify: HDX-☐-☐-☐

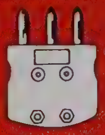
1. HDX heavy duty handle.
2. Type of connector in handle.
3. Calibration
4. Connector on cable.

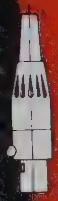
. . . with Extension Leads

OMEGA's heavy duty cast aluminum handles provide a fast, easy to use system of handheld probes. The sensing element can be quickly changed or replaced in the field without tools. If desired, the strain relieved retractile cable can also be replaced by other types of thermocouple wire. With one handle and several probes, a complete test system can be assembled with a minimum of weight and space in your toolbox.

$30 Includes 1 ft. retractable cable and connector.

Extra Cable:
$5/ft. for T/C
$4/ft. for RTD, Thermistor





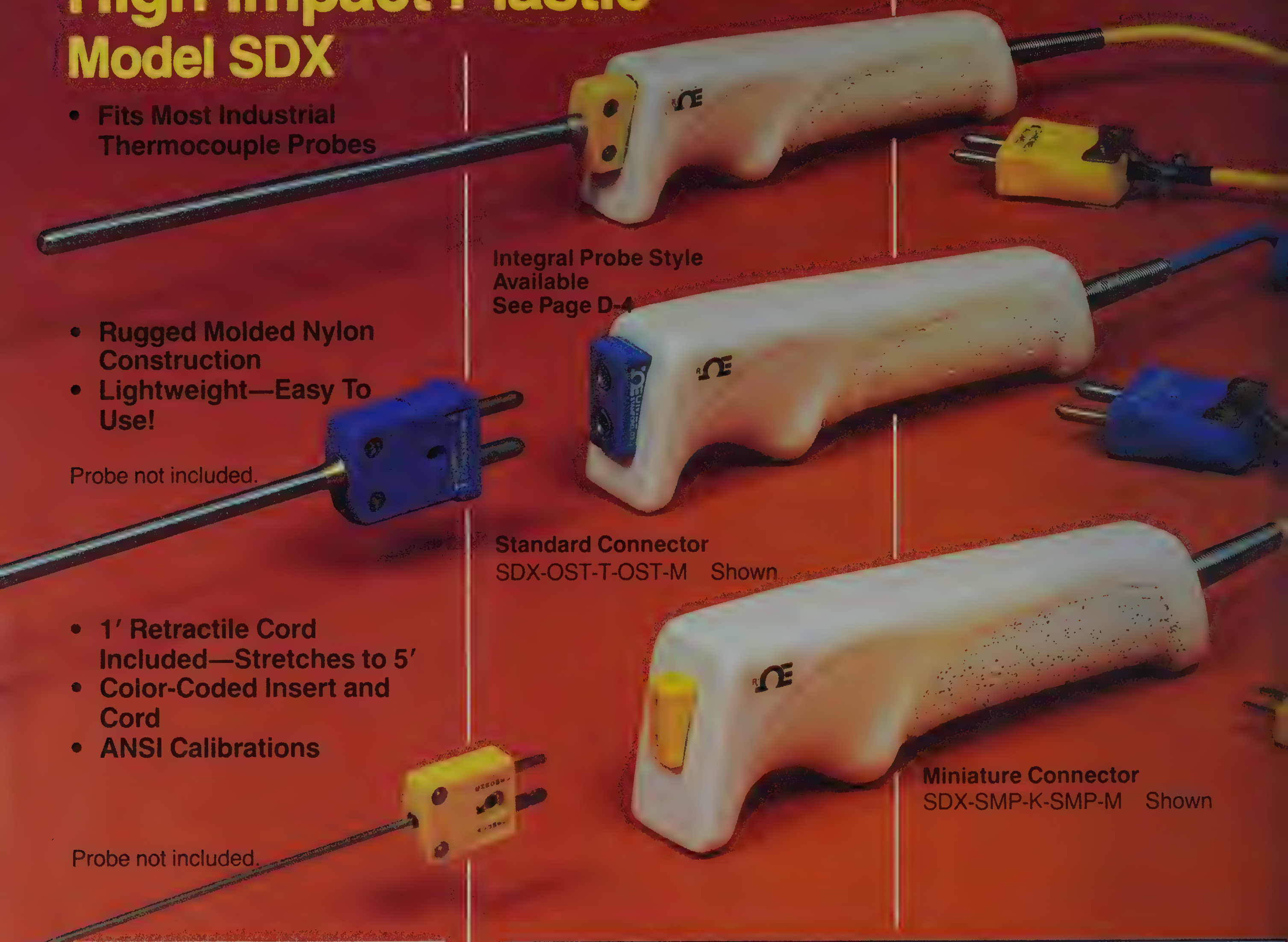
Handle Connector	Connector on Retractable Cable				
	OST See page G-7	**SMP** See page G-13	**OTP** See page G-10	**PP** Phone Plug 2 & 3 Wire	"**T**" See page G-25 Uncompensated
OST **OGP** **NOX**	HDX-OST-☐-OST-M **$30.00** HDX-OST-☐-OST-F **$30.00**	HDX-OST-☐-SMP-M **$30.00** HDX-OST-☐-SMP-F **$30.00**	HDX-OST-☐-OTP-M **$30.00** HDX-OST-☐-OTP-F **$30.00**	HDX-OST-U-PP2 **$30.00** HDX-OST-U-PP3 **$30.00**	HDX-OST-U-TA3ML **$30.00** HDX-OST-U-TA3FL **$30.00**
SMP **NMP**	HDX-SMP-☐-OST-M **$30.00** HDX-SMP-☐-OST-F **$30.00**	HDX-SMP-☐-SMP-M **$30.00** HDX-SMP-☐-SMP-F **$30.00**	HDX-SMP-☐-OTP-M **$30.00** HDX-SMP-☐-OTP-F **$30.00**	HDX-SMP-U-PP2 **$30.00** HDX-SMP-U-PP3 **$30.00**	HDX-SMP-U-TA3ML **$30.00** HDX-SMP-U-TA3FL **$30.00**
OTP	HDX-OTP-☐-OST-M **$30.00** HDX-OTP-☐-OST-F **$30.00**	HDX-OTP-☐-SMP-M **$30.00** HDX-OTP-☐-SMP-F **$30.00**	HDX-OTP-☐-OTP-M **$30.00** HDX-OTP-☐-OTP-F **$30.00**	HDX-OTP-U-PP2 **$30.00** HDX-OTP-U-PP3 **$30.00**	HDX-OTP-U-TA3ML **$30.00** HDX-OTP-U-TA3FL **$30.00**

NOTE: Listed assemblies have one foot of retractile cord. For other construction consult the Sales Department.

☐ Select Calibration: **K** = Chromel-Alumel
J = Iron-Constantan
T = Copper-Constantan
E = Chromel-Constantan
U = Copper

Probe Handles
High Impact Plastic
Model SDX

- **Fits Most Industrial Thermocouple Probes**



Integral Probe Style Available See Page D-4

- **Rugged Molded Nylon Construction**
- **Lightweight—Easy To Use!**

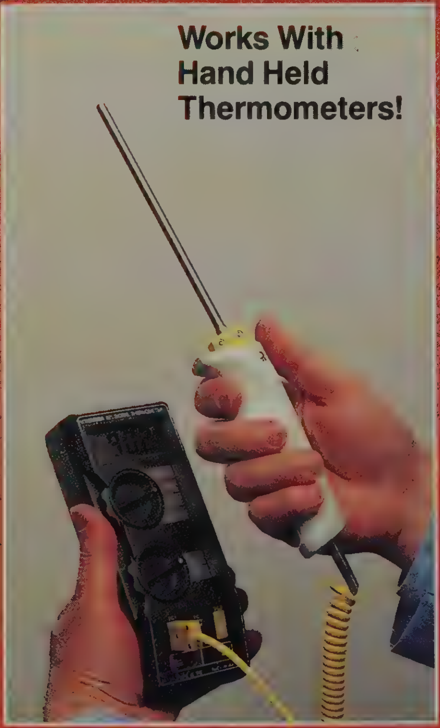
Probe not included.

Standard Connector
SDX-OST-T-OST-M Shown

- **1′ Retractile Cord Included—Stretches to 5′**
- **Color-Coded Insert and Cord**
- **ANSI Calibrations**

Miniature Connector
SDX-SMP-K-SMP-M Shown

Probe not included.



Works With Hand Held Thermometers!

Handle Con-nector	Connector on Retractable Cable		
	OST See page G-7	**SMP** See page G-13	**PP** Phone Plug 2 Wire
OST	SDX-OST-☐-OST-M **$25.00** SDX-OST-☐-OST-F **$25.00**	SDX-OST-☐-SMP-M **$25.00** SDX-OST-☐-SMP-F **$25.00**	SDX-OST-U-PP2 **$25.00**
SMP	SDX-SMP-☐-OST-M **$25.00** SDX-SMP-☐-OST-F **$25.00**	SDX-SMP-☐-SMP-M **$25.00** SDX-SMP-☐-SMP-F **$25.00**	SDX-SMP-U-PP2 **$25.00**

NOTE: Listed assemblies have one foot of retractile cord. For other construction consult the Sales Department.
☐ Select Calibration: **K** = Chromel-Alumel **J** = Iron-Constantan **T** = Copper-Constantan
E = Chromel-Constantan **U** = Copper

HOW TO ORDER

Specify: SDX-☐-☐-☐

1. Handle Connector
2. Calibration
3. Cable Connector

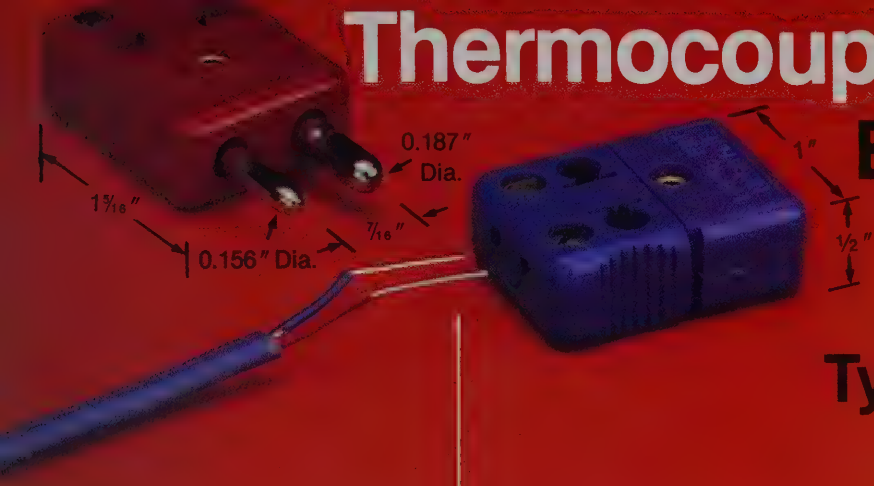
Quantity Discounts

1 - 10	Net
11 - 24	10%
25 - 49	15%
50 - 99	20%
100 - 999	25%
1000 and over	Consult Factory

Thermocouple Connectors

Extra Heavy Duty Solid Pin Construction

Type OGP Color coded



With "Quick Wiring Cap!"

OFF-THE-SHELF DELIVERY

Alloy Code*	Type of Thermocouple Used With Connector	Compensating Alloy Used in Connector		Shell Color	Catalog Number Pair†	Price		
		+	−			Pair (MF)	Female (F)	Male (M)
K	Chromel-Alumel	Chromel	Alumel	Yellow	OGP-K-MF	$11	$6	$5
T	Copper-Constantan	Copper	Constantan	Blue	OGP-T-MF	9	5	4
J	Iron-Constantan	Iron	Constantan	Black	OGP-J-MF	9	5	4
E	Chromel-Constantan	Chromel	Constantan	Purple	OGP-E-MF	11	6	5
R	Pt-Pt/13%Rh	Copper	Alloy #11	Green	OGP-R-MF	11	6	5
S	Pt-Pt/10%Rh	Copper	Alloy #11	Green	OGP-S-MF	11	6	5
G	W-W/26%Re	Alloy #200	Alloy #226	Red/Grn	OGP-G-MF	11	6	5
C	W/5%Re-W/26%Re	Alloy #405	Alloy #426	Red	OGP-C-MF	11	6	5
D	W/3%Re-W/25%Re	Alloy #203	Alloy #225	Red/Wht	OGP-D-MF	11	6	5
U	Uncompensated	Copper	Copper	White	OGP-U-MF	9	5	4

K, T, J, E, R, S & B are ANSI designations.

When ordering separate Male or Female connectors, use he suffix M or F only.

OTE: Type U (Uncompensated) connectors are used with pe B thermocouples (Platinum/6% Rhodium-Platinum 0% Rhodium).

NEW LOW PRICES

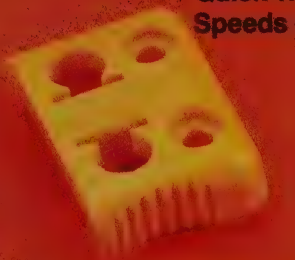
Type OGP connectors are constructed to provide the maximum durability and service. The thick-wall, glass filled nylon bodies have a maximum service temperature of 425 °F (218 °C). The heavy duty contacts are machined from solid rod stock of matched alloys and are designed to prevent reverse mating of polarity. OGP connectors will mate with OST and other standard size thermocouple alloy connectors. They are available in all calibrations including those compatible with OMEGA's Tungsten-Rhenium thermocouples.

OGP connectors are now supplied with a quick wiring cap and a standard cap. The quick wiring cap accepts wires as large as 14 gage solid (16 gage stranded). To install, just loosen two screws, slide the wires in and tighten. Quick, dependable connections can be made in seconds with no loose parts.

CUSTOM ASSEMBLIES

Custom versions of OGP as well as other types of OMEGA connectors can be provided on special order. Color coding can be supplied to match DIN, JIS, BS, or proprietary codes, with either hot stamp or printed company name or logo. Consult Sales Department for prices and minimum quantity.

Closed cap



Quick Wiring Cap Speeds installation

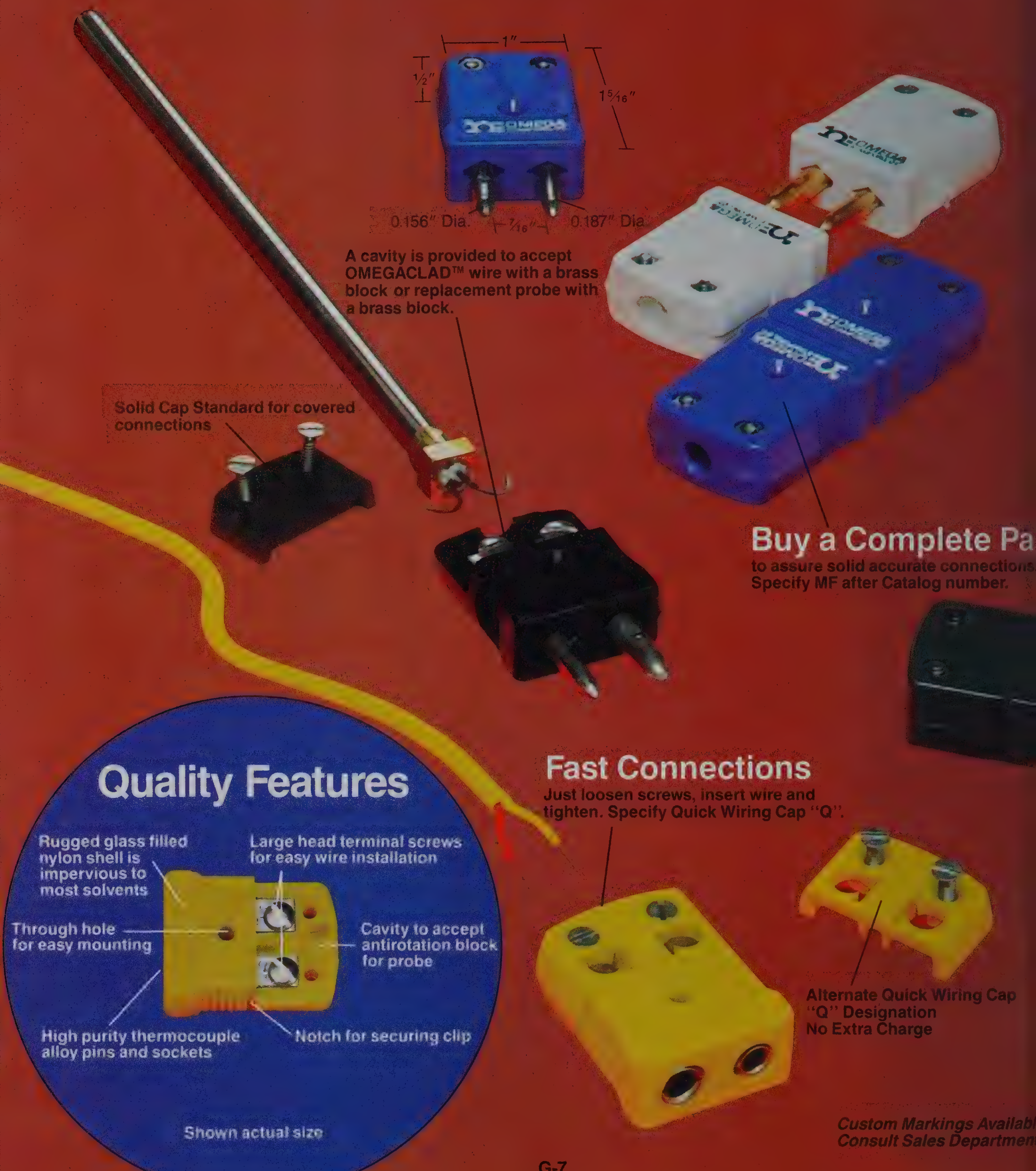
(Both caps supplied)

Custom Marking Available

Quantity Discounts	
1 - 10	Net
11 - 24	10%
25 - 49	15%
50 - 99	20%
100 - 999	25%
1000 and over	Consult Factory

Thermocouple Connectors
Quick Disconnect Type OST Color Code

Easy-to-Use Two Piece Construction



A cavity is provided to accept OMEGACLAD™ wire with a brass block or replacement probe with a brass block.

Solid Cap Standard for covered connections

Buy a Complete Pa

to assure solid accurate connections. Specify MF after Catalog number.

Quality Features

Rugged glass filled nylon shell is impervious to most solvents

Large head terminal screws for easy wire installation

Through hole for easy mounting

Cavity to accept antirotation block for probe

High purity thermocouple alloy pins and sockets

Notch for securing clip

Shown actual size

Fast Connections

Just loosen screws, insert wire and tighten. Specify Quick Wiring Cap "Q".

Alternate Quick Wiring Cap
"Q" Designation
No Extra Charge

Custom Markings Availabl
Consult Sales Departmen

Added features when you use OMEGA® connectors.

NEW LOW PRICES

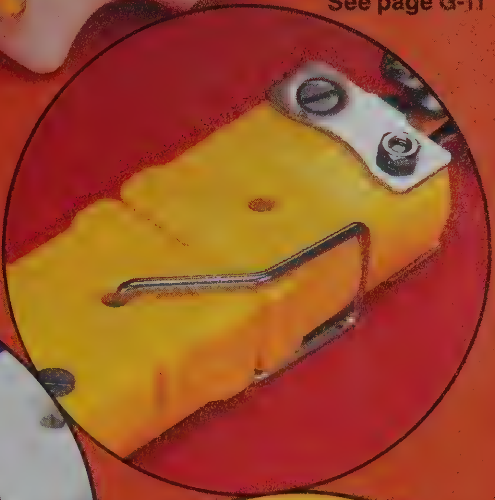
Mates with OMEGA probes and handles. See Sections A, B and D

Type OST quick disconnect plugs and jacks provide reliable connections in thermocouple circuits. Excellent thermal as well as electrical characteristics of the thermocouple grade contacts assure high accuracy. The color coded bodies are molded of high impact strength glass filled nylon which will withstand ambient temperatures up to 425°F (218°C). The tubular prongs and collet-type receptacles are polarized to prevent an alloy reversal. The type OST connector mates with panel jack and other standard size connectors.

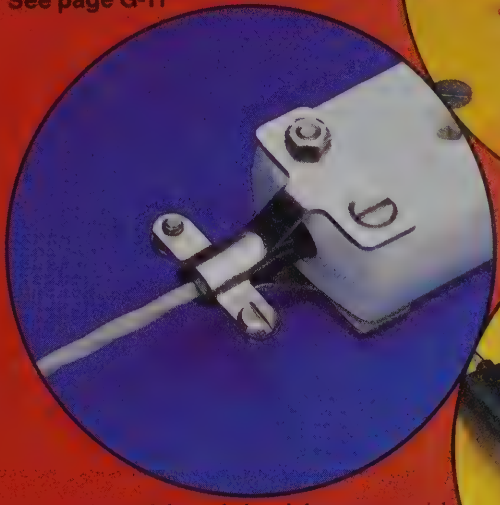
Brass blocks are available for use in the OST connectors where support is needed for a sheathed probe or tubing. Consult the Sales Department for further information.

Quick wiring caps can be substituted for the solid cover on OST connectors at no extra cost. To connect the lead wire, just loosen two screws, insert the conductors and tighten. Quick, dependable connectors can be made in seconds using a maximum of 14 AWG wire. Caps can be ordered with the connector or as a replacement.

Securing Clip, SFCL
See page G-11



Strain Relief Brackets, PCLM
See page G-11



Watertight Jackets, SRB
See page G-12

To order with quick wiring cap add the suffix "Q" to the connector part number (no extra charge). For replacement caps—specify OST "Quick Wiring Cap" $0.25 each.

Dimensions:

Body H: ½″ × **W:** 1″ × **D:** 1⁵⁄₁₆″
Pins: Pos. 0.156 Dia.; Neg. 0.187 Dia.; ⁷⁄₁₆″ center to center.

OFF-THE-SHELF DELIVERY

Alloy Code*	Type of Thermocouple Used With Connector	Compensating Alloy Used in Connector +	−	Shell Color	Catalog Number Pair†	Price Pair (MF)	Price Female (F)	Price Male (M)
K	Chromel-Alumel	Chromel	Alumel	Yellow	OST-K-MF	$5.65	$3.40	$2.25
T	Copper-Constantan	Copper	Constantan	Blue	OST-T-MF			
J	Iron-Constantan	Iron	Constantan	Black	OST-J-MF			
E	Chromel-Constantan	Chromel	Constantan	Purple	OST-E-MF			
R	Pt-Pt/13%Rh	Copper	Alloy #11	Green	OST-R-MF			
S	Pt-Pt/10%Rh	Copper	Alloy #11	Green	OST-S-MF			
U	Uncompensated	Copper	Copper	White	OST-U-MF			

Quantity Discounts	
1 - 10	Net
11 - 24	10%
25 - 49	15%
50 - 99	20%
100 - 999	25%
1000 and over	Consult Factory

*K, T, J, E, R, S & B are ANSI designations.
†When ordering separate Male or Female connectors, use the suffix M or F only.

NOTE: Type U (Uncompensated) connectors are used with type B thermocouples (Platinum/6% Rhodium-Platinum 30% Rhodium).

Thermocouple Connectors

K CHROMEGA + ALUMEL –

Ultra-High Temperature

OMEGA ceramic connectors are available in two standard styles, either with a color coded glaze (NOX) or unglazed white (UOX). The color code conforms to ANSI and OMEGA standards and can also be supplied to other standards or special order. UOX connectors should be used when glazed ceramic or nylon connectors would contaminate vacuum systems. Temperature is limited only by the hardware. Chromel-Alumel, Iron-Constantan and Chromel-Constantan can be used at temperatures up to 1200°F (650°C) and Copper-Constantan can be used accurately over its entire calibration range 750°F (390°C). Noble metal and refractory metal calibrations are limited by the compensating alloys to ambient use of 500°F (260°C). No damage will be done by exposure to higher temperatures, but accuracies may exceed limits of error if a temperature gradient exists across the connector.

CUSTOM ASSEMBLIES

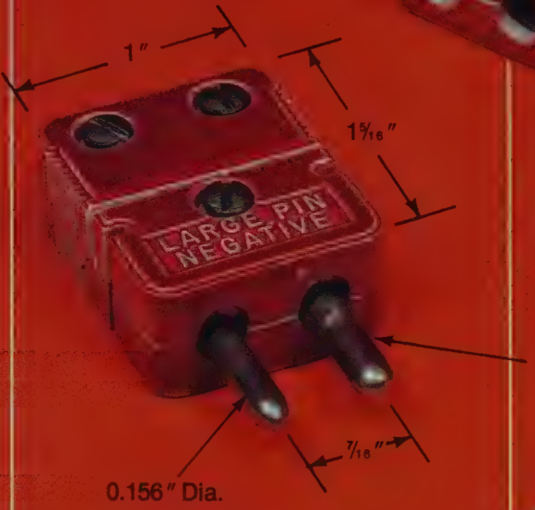
Custom versions of NOX as well as other types of OMEGA connectors can be provided on special order. Color coding can be supplied to match DIN, JIS, BS, or proprietary codes, with printed company name or logo. Consult Sales Department for prices and minimum quantity. Ceramic connectors are brittle. Use only when operating conditions do not allow the use of OST or OGP connectors.

Types NOX and UOX

Color Coded and Unglazed White Ceramic Bodies

Solid Pin Construction

LARGE PIN NEGATIVE



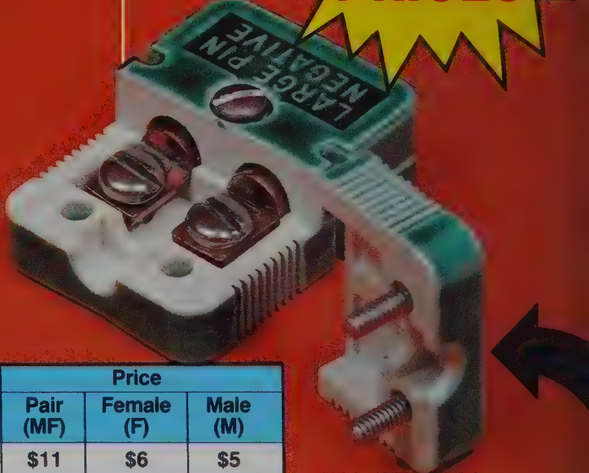
CERAMIC

To order **unglazed** white shells, replace NOX with UOX in the catalog designation. Price is the same.

NEW LOW PRICES

Quantity Discounts

1 - 10	Net
11 - 24	10%
25 - 49	15%
50 - 99	20%
100 - 999	25%
1000 and over	Consult Sales Department



Exclusive Split Shell Design Simplifies Wiring!

Off-The-Shelf Delivery

Alloy Code*	Type of Thermocouple Used With Connector	Compensating Alloy Used in Connector		Shell Color	Catalog Number Pair†	Price		
		+	–			Pair (MF)	Female (F)	Male (M)
K	Chromel-Alumel	Chromel	Alumel	Yellow	NOX-K-MF	$11	$6	$5
T	Copper-Constantan	Copper	Constantan	Blue	NOX-T-MF	10	6	4
J	Iron-Constantan	Iron	Constantan	Black	NOX-J-MF	10	6	4
E	Chromel-Constantan	Chromel	Constantan	Purple	NOX-E-MF	11	6	5
R	Pt-Pt/13%Rh	Copper	Alloy #11	Green	NOX-R-MF	11	6	5
S	Pt-Pt/10%Rh	Copper	Alloy #11	Green	NOX-S-MF	11	6	5
G	W-W/26%Re	Alloy #200	Alloy #226	Red/Grn	NOX-G-MF	11	6	5
C	W/5%Re-W/26%Re	Alloy #405	Alloy #426	Red	NOX-C-MF	11	6	5
D	W/3%Re-W/25%Re	Alloy #203	Alloy #225	Red/Wht	NOX-D-MF	11	6	5
U	Uncompensated	Copper	Copper	White	NOX-U-MF	10	6	4

*K, T, J, E, R, S & B are ANSI designations.

†When ordering separate Male or Female connectors, use the suffix M or F only.

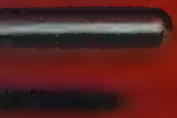
NOTE: Type U (Uncompensated) connectors are used with type B thermocouples (Platinum/6% Rhodium-Platinum 30% Rhodium).

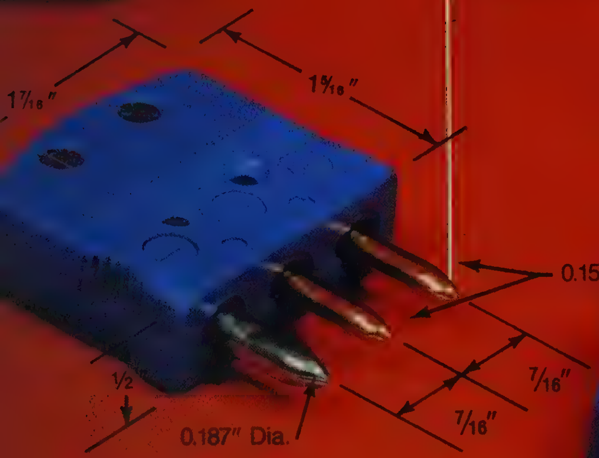
Thermocouple Connectors

3-Prong Heavy Duty

Type OTP Color Coded

With Shield Connection Pin





Male (plug)

3-PRONG

Large head terminal screws/holes provided for clamps and tube adaptors.

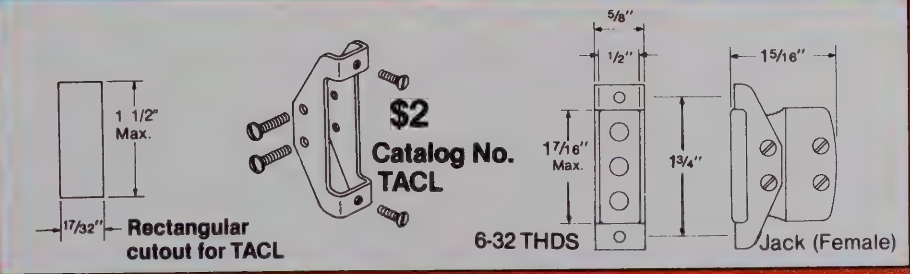
PCLM Cable Clamp
page **G-11**

Female (jack)

The type OTP 3-prong color coded, quick disconnect plugs and jacks provide reliable connections between thermocouples and extension wires. The color coded bodies are molded of high performance glass reinforced nylon. Tubular plug prongs and collet-type jack inserts have low mass and reduce temperature gradients. Negative prongs and inserts are larger than positives to insure proper polarity upon connection. This is a standard feature on all OMEGA connectors. Recommended for most applications requiring three wire circuits including shielded thermocouples, thermistors, and RTD's. Will withstand ambient temperatures to 425 °F (218 °C). High impact construction.

NEW LOW PRICES

Panel Adaptor Clips for Mounting 3-Prong Plugs and Jacks



Rectangular cutout for TACL

$2
Catalog No. TACL

Off-The-Shelf Delivery

Alloy Code*	Type of Thermocouple Used With Connector	Compensating Alloy Used in Connector +	Compensating Alloy Used in Connector −	Shell Color	Catalog Number Pair†	Price Pair (MF)	Price Female (F)	Price Male (M)
K	Chromel-Alumel	Chromel	Alumel	Yellow	OTP-K-MF	$9.00	$5.50	$3.50
T	Copper-Constantan	Copper	Constantan	Blue	OTP-T-MF	9.00	5.50	3.50
J	Iron-Constantan	Iron	Constantan	Black	OTP-J-MF	9.00	5.50	3.50
E	Chromel-Constantan	Chromel	Constantan	Purple	OTP-E-MF	9.00	5.50	3.50
U	Uncompensated	Copper	Copper	White	OTP-U-MF	9.00	5.50	3.50

Quantity Discounts

1 - 10	Net
11 - 24	10%
25 - 49	15%
50 - 99	20%
100 - 999	25%
1000 and over	Consult Sales Department

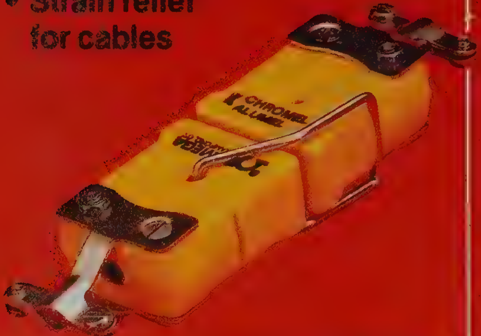
K, T, J, E, & B are ANSI designations. † When ordering separate Male or Female connectors, use the suffix M or F only.

NOTE: Type U (Uncompensated) connectors are used with type B thermocouples (Platinum/6% Rhodium-Platinum 30% Rhodium).

Accessory Hardware

Cable Clamps PCLM

- For all standard size connectors
  - OST
  - OGP
  - NOX
  - OTP
- Strain relief for cables



ORDER: PCLM

$1 each

Safety Clips SFCL

- Prevents Accidental Disconnects
- Self-retaining
- Fits OST, OGP Connectors
- Reusable

.50¢ pkg. of 10

NOTE: Must be used with connectors having a retainer groove molded into the shell. These connectors were first supplied in Spring of 1982.

Tube Clamps Single Element X-BRLK

Extra heavy duty, consists of OMEGA's brass compression fitting with a connector adaptor.

COPPER
COPPER

$3 each

Tube Size O.D.	Catalog Number	Price
1/16"	X-BRLK-116	$3
1/8"	X-BRLK-18	3
3/16"	X-BRLK-316	3
1/4"	X-BRLK-14	3

Tube Clamps Dual Element DX-BRLK

To accommodate four wire thermocouple probes. Mounts two OST, OGP, OTP, or NOX connectors.

$7 each

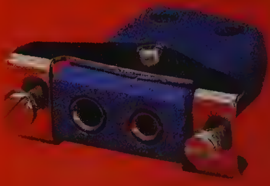
Tube Size O.D.	Catalog Number	Price
1/16"	DX-BRLK-116	$7
1/8"	DX-BRLK-18	7
3/16"	DX-BRLK-316	7
1/4"	DX-BRLK-14	7

Panel Adaptors

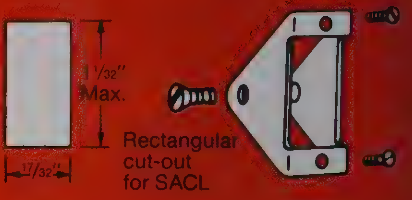
for any standard size OMEGA connectors

Single circuit adaptors fit OMEGA OST and OGP connectors. Facilitates easy mounting in control panels and instrument cases. Type SACL adaptor requires a rectangular knock-out hole and is suited for close stacking of several connectors. Type RSACL holds tight in easily made round knock-out holes. All screws and mounting hardware included.

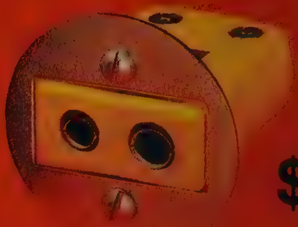
Catalog No. SACL



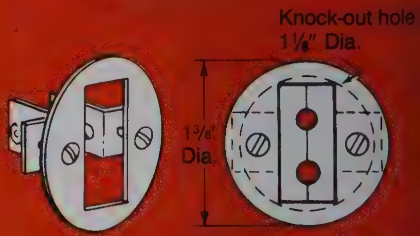
$2 each

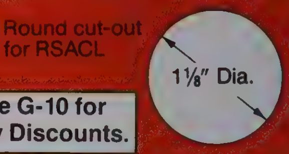


Catalog No. RSACL



$3 eac





See page G-10 for Quantity Discounts.

Rubber Boots

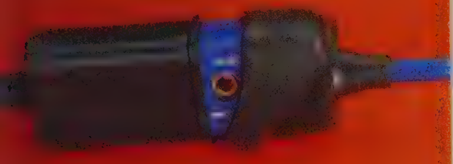
Weatherize Your Connections

SRB $2.00/Per Pair

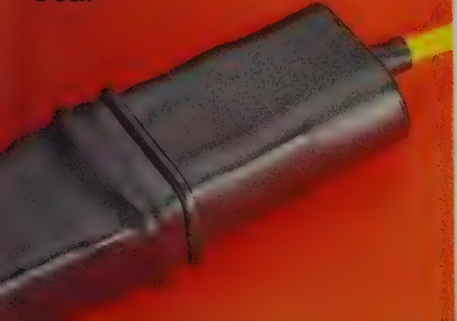
SRB Standard Size fits
DST & OGP Connectors

MRB $1.50/Per Pair

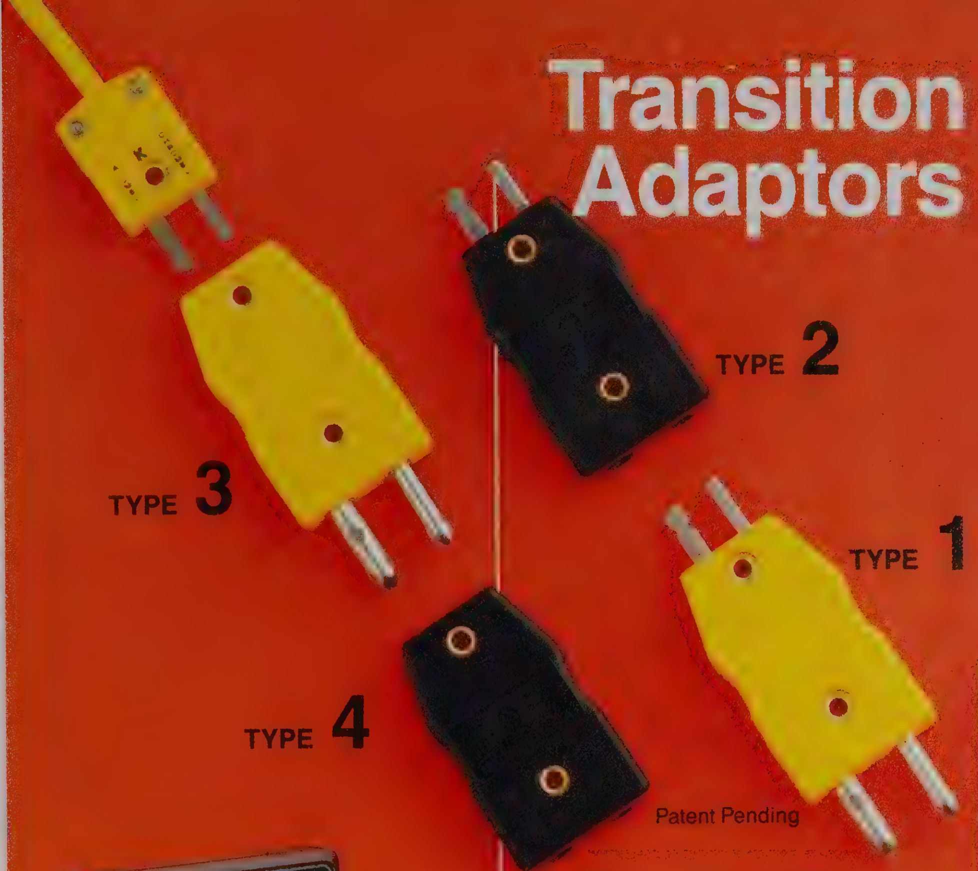
MRB Miniature Size fits
SMP Connectors



- **Easy to Install**
- **Tapered Wire Entry**
- **Overlap For Weathertight Seal**



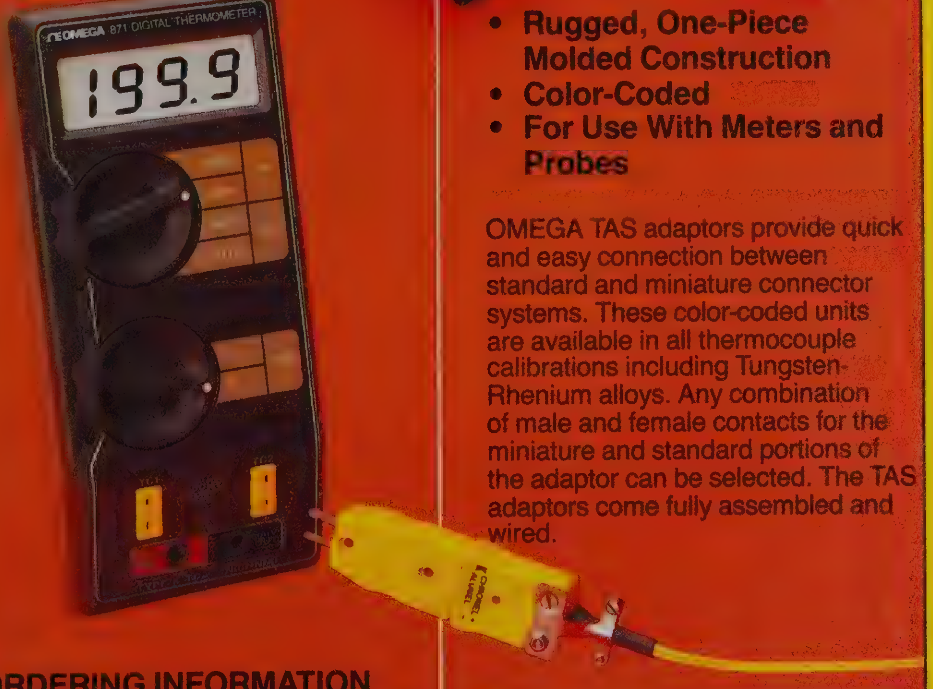
Transition Adaptors



Patent Pending

- **Rugged, One-Piece Molded Construction**
- **Color-Coded**
- **For Use With Meters and Probes**

OMEGA TAS adaptors provide quick and easy connection between standard and miniature connector systems. These color-coded units are available in all thermocouple calibrations including Tungsten-Rhenium alloys. Any combination of male and female contacts for the miniature and standard portions of the adaptor can be selected. The TAS adaptors come fully assembled and wired.



ORDERING INFORMATION

TAS Calibration Configuration	Price
TAS- J -[*] TAS- K -[*] TAS- T -[*] TAS- E -[*] TAS- R/S-[*] TAS- U -[*]	$5.00
TAS- G -[*] TAS- C -[*] TAS- D -[*]	$6.00

*Add Configuration Code.

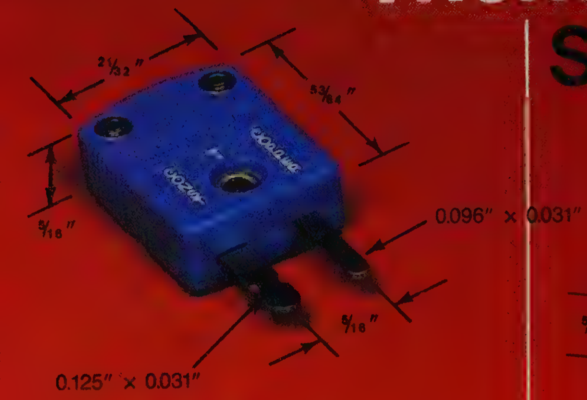
Standard End	Miniature End	Adaptor Type
Male	Male	1
Female	Male	2
Male	Female	3
Female	Female	4

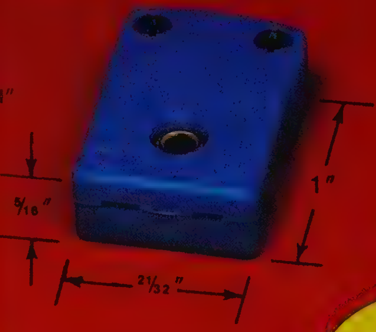
EXAMPLE: TAS-K-3 is a standard male to miniature female adaptor for type K thermocouples.

Thermocouple Connectors

Subminiature, Type SMP

Color Coded

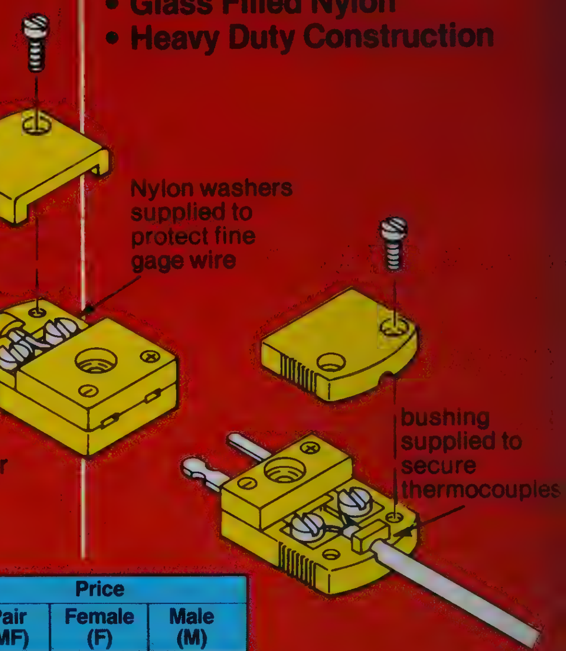




- **OMEGA's Smallest Thermocouple Connector**
- **Glass Filled Nylon**
- **Heavy Duty Construction**

NEW LOW PRICES

Shown slightly larger than actual size.



Nylon washers supplied to protect fine gage wire

bushing supplied to secure thermocouples

Off-The-Shelf Delivery

Alloy Code*	Type of Thermocouple Used With Connector	Compensating Alloy Used in Connector +	Compensating Alloy Used in Connector −	Shell Color	Catalog Number Pair†	Price Pair (MF)	Price Female (F)	Price Male (M)
K	Chromel-Alumel	Chromel	Alumel	Yellow	SMP-K-MF	$4.00	$2.25	$1.75
T	Copper-Constantan	Copper	Constantan	Blue	SMP-T-MF	4.00	2.25	1.75
J	Iron-Constantan	Iron	Constantan	Black	SMP-J-MF	4.00	2.25	1.75
E	Chromel-Constantan	Chromel	Constantan	Purple	SMP-E-MF	4.00	2.25	1.75
R	Pt-Pt/13%Rh	Copper	Alloy #11	Green	SMP-R-MF	4.00	2.25	1.75
S	Pt-Pt/10%Rh	Copper	Alloy #11	Green	SMP-S-MF	4.00	2.25	1.75
G	W-W/26%Re	Alloy #200	Alloy #226	Red/Grn	SMP-G-MF	4.00	2.25	1.75
C	W/5%Re-W/26%Re	Alloy #405	Alloy #426	Red	SMP-C-MF	4.00	2.25	1.75
D	W/3%Re-W/25%Re	Alloy #203	Alloy #225	Red/Wht	SMP-D-MF	4.00	2.25	1.75
U	Uncompensated	Copper	Copper	White	SMP-U-MF	4.00	2.25	1.75

*K, T, J, E, R, S & B are ANSI designations.

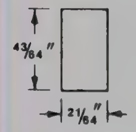
†When ordering separate Male or Female connectors, use the suffix M or F only.

NOTE: Type U (Uncompensated) connectors are used with type B thermocouples (Platinum/6% Rhodium-Platinum 30% Rhodium).

OMEGA's subminiature connectors are molded of high performance glass filled nylon. Tube clamps are not required. Each male connector is supplied with one blank brass bushing to which protection tubes are easily soldered or brazed.
Special washers are provided to guarantee good contact without damaging fine wires. Connector will accommodate protection tubes from 0.010″ to ⅛″ (0.25 mm to 3.17 mm) O.D. Additional bushings may be purchased for $.25 each. Please specify SMP Brass Block.

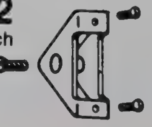
Panel Adaptor Clips for Mounting Miniature Size Plugs and Jacks

Single circuit adaptors for OMEGA's subminiature SMP connectors facilitate easy mounting in control panels and instrument cases. Type SMACL adaptor requires a rectangular knock-out hole and is suited for close stacking of several connectors. Type SRMACL holds tight in easily made round knock-out holes. All screws and mounting hardware included.

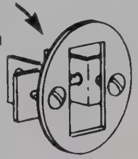


Rectangular cutout for SMACL

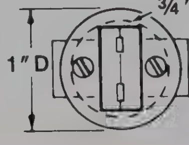
Catalog No. **SMACL**
$2 each

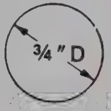


Catalog No. **SRMACL**
$2 each



Knock-out hole, ¾″ Dia.





Round cutout for SRMACL

DIFFERENT COLOR CODES ALSO AVAILABLE!

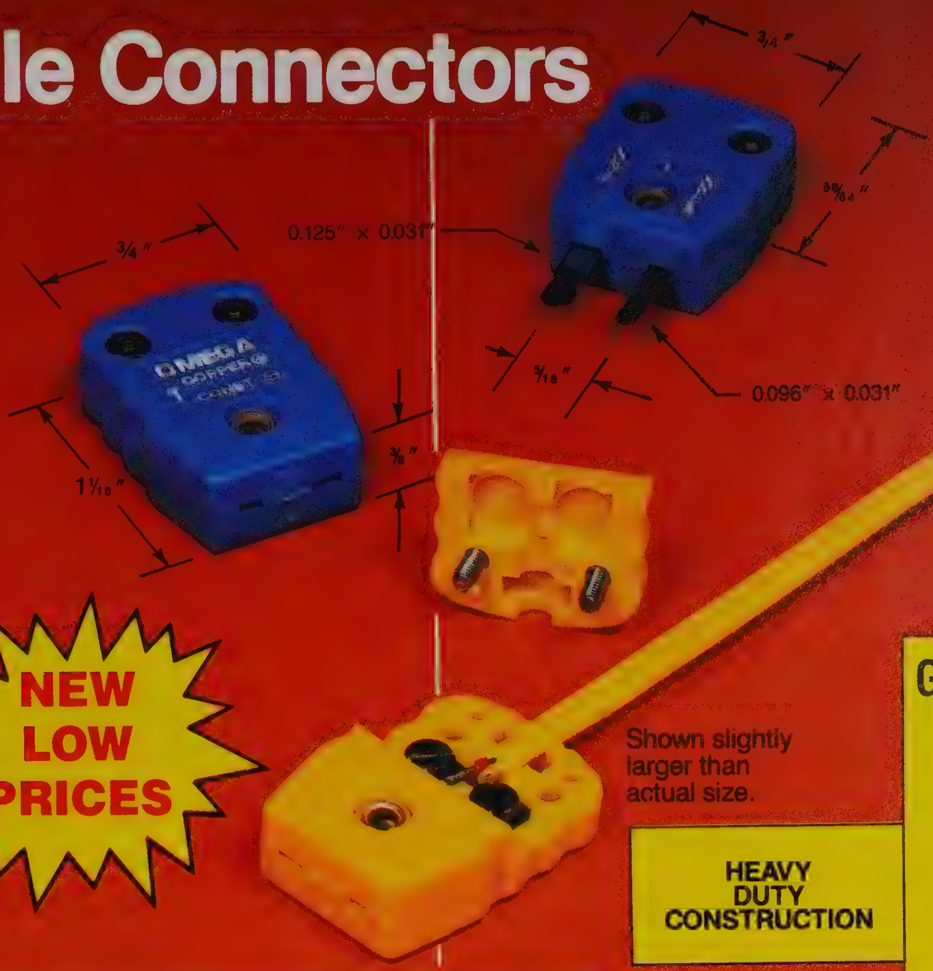
CUSTOM ASSEMBLIES

Custom versions of SMP as well as other types of OMEGA connectors can be provided on special order. Color coding can be supplied to match DIN, JIS, BS, or proprietary codes, with either hot stamp or printed company name or logo. Consult Sales Department for prices and minimum quantity.

Thermocouple Connectors

Miniature
Type NMP
Color Coded

OMEGA's miniature heavy duty connectors are recommended for use with fine gage thermocouple wires and protection tubes where standard size connectors become unwieldy. OMEGA's miniature connector will accommodate protection tubes from 0.010" to ⅛" O.D. (0.25 mm to 3.1 mm).
One blank brass bushing is furnished with each male connector which can be drilled to accept protection tubes with either soldering or brazing. Special washers are provided to guarantee good contact without damaging fine wires.



Shown slightly larger than actual size.

NEW LOW PRICES

HEAVY DUTY CONSTRUCTION

DIFFERENT COLOR CODES ALSO AVAILABLE!

Consult Sales Department

Off-The-Shelf Delivery

Alloy Code*	Type of Thermocouple Used With Connector	Compensating Alloy Used in Connector		Shell Color	Catalog Number Pair†	Price		
		+	−			Pair (MF)	Female (F)	Male (M)
K	Chromel-Alumel	Chromel	Alumel	Yellow	NMP-K-MF	$4.25	$2.30	$1.95
T	Copper-Constantan	Copper	Constantan	Blue	NMP-T-MF	4.25	2.30	1.95
J	Iron-Constantan	Iron	Constantan	Black	NMP-J-MF	4.25	2.30	1.95
E	Chromel-Constantan	Chromel	Constantan	Purple	NMP-E-MF	4.25	2.30	1.95
R	Pt-Pt/13%Rh	Copper	Alloy #11	Green	NMP-R-MF	4.25	2.30	1.95
S	Pt-Pt/10%Rh	Copper	Alloy #11	Green	NMP-S-MF	4.25	2.30	1.95
G	W-W/26%Re	Alloy #200	Alloy #226	Red/Grn	NMP-G-MF	4.25	2.30	1.95
C	W/5%Re-W/26%Re	Alloy #405	Alloy #426	Red	NMP-C-MF	4.25	2.30	1.95
D	W/3%Re-W/25%Re	Alloy #203	Alloy #225	Red/Wht	NMP-D-MF	4.25	2.30	1.95
U	Uncompensated	Copper	Copper	White	NMP-U-MF	4.25	2.30	1.95

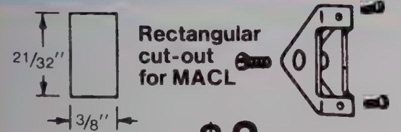
* K, T, J, E, R, S & B are ANSI designations. † When ordering separate Male or Female connectors, use the suffix M or F only.
NOTE: Type U (Uncompensated) connectors are used with type B thermocouples (Platinum/6% Rhodium-Platinum 30% Rhodium).

Quantity Discounts

Quantity	Discount
1 - 10	Net
11 - 24	10%
25 - 49	15%
50 - 99	20%
100 - 999	25%
1000 and over	**Consult Sales Department**

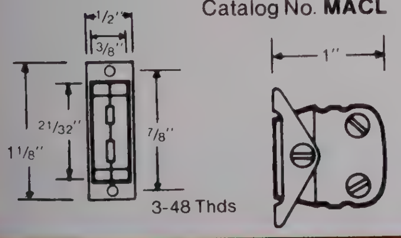
Additional bushings may be purchased for $0.25 each. Please specify NMP Brass Block.

Panel Adaptor Clips for Mounting Miniature Size Plugs and Jacks

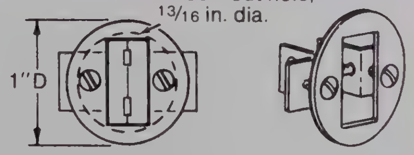


Rectangular cut-out for MACL

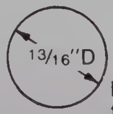
$ 2 each
Catalog No. **MACL**



Single circuit adaptors for OMEGA's miniature NMP connectors facilitate easy mounting in control panels and instrument cases. Type MACL adaptor requires a rectangular knock-out hole and is suited for close stacking of several connectors. Type RMAC holds tight in easily made, round knock-out holes. All screws and mounting hardware included.



$ 2 each
Catalog No. **RMACL**



Round cut-out for RMACL

Thermocouple Connectors
Multipin

ALTHOUGH THE CONNECTORS DO NOT CARRY A MIL. SPEC. NUMBER, THEY DO MEET THE PERFORMANCE REQUIREMENTS OF MIL-C-26500E AND ARE INTERMATEABLE WITH MIL-C-26500 CONNECTORS.

OMEGA sturdy multipin connectors provide an efficient means of joining multiwire thermocouple cables. They can be used with OMEGA's multipair extension cable* for rapid, convenient connection and dismantling of apparatus without handling individual sensors.

The design utilizes a combination of resilient and rigid dielectric insulators to eliminate internal air voids and prevent the passage of air and moisture into or through the connector. Connectors can withstand ambient temperatures up to 392°F (200°C), contributing to an extended connector life.

*See Section H

- **Thermocouple Alloy Pins**
- **Air and Moisture Resistant Connection**
- **Rated to 392°F (200°C)**
- **Removable Crimp Contacts**
- **20-24 AWG Wire**
- **Aluminum Shells**
- **Black Anodize Finish**
- **Threaded Coupling**

Backshell Cable Clamp

In-Line Cord Connector with Optional Backshel Cable Clamp

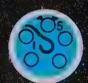
Rugged Flanged Body for Bulkhead and Chassis Mounting

Prices start at

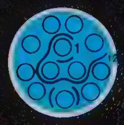
$29

for Five Cavity Female Flanged Connector—Pins extra.

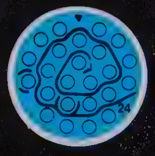
Contact cavities are identified with a spiral guide line indicating cavity sequence. The first and last cavities are numbered and every tenth cavity is bracketed.



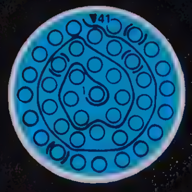
5 Pin



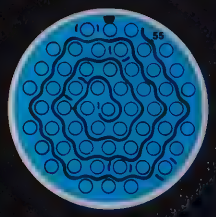
12 Pin



24 Pin



41 Pin

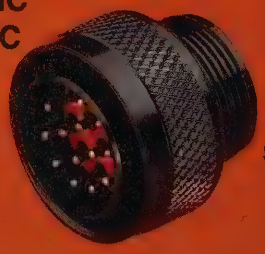


55 Pin

Style FF

Flange mounted receptacle with threaded coupling. Uses sockets only.

Styles MC FC



In-line cord connectors with threaded couplings. Style MC uses Pins, style FC uses sockets.

Multipin Connector Bodies*

Number of Cavities	MC Male Cord	Price	FC Female Cord	Price	FF Female Flanged	Price	Backshell Cable Clamp**	Price
5	MTC- 5-MC	$30	MTC- 5-FC	$43	MTC- 5-FF	$29	MTC- 5-SHL	$16
12	MTC-12-MC	32	MTC-12-FC	46	MTC-12-FF	31	MTC-12-SHL	18
24	MTC-24-MC	36	MTC-24-FC	49	MTC-24-FF	35	MTC-24-SHL	20
41	MTC-41-MC	47	MTC-41-FC	58	MTC-41-FF	43	MTC-41-SHL	22
55	MTC-55-MC	49	MTC-55-FC	59	MTC-55-FF	44	MTC-55-SHL	24

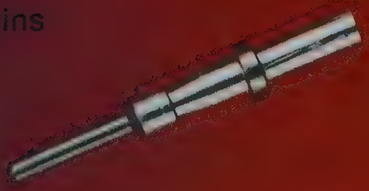
*Contacts not included. Order from opposite page.

**Backshell cable clamps provide effective support for the cable at the male or female connector and prevent twisting and pulling.

NEW!

Thermocouple Contacts
For Multipin Connectors

ins



Sockets

- **Crimp-Type Attachment**
- **Contacts are Color Coded**
- **Accessories Available**

OMEGA push in crimp style contacts are machined from thermocouple alloy materials and color coded for easy identification. Contacts are crimp terminated outside the connector assembly and inserted into the appropriate cavity by means of an insertion tool. They can be readily removed from the connector assembly using a special removal tool. Sealing plugs are available to seal unused positions in lieu of pin or socket.

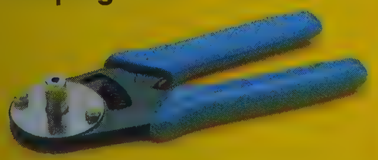
Alloy Type	Pins (Male)	Coding Color Letter	Price	Sockets (Female)	Coding Color Letter	Price
Iron (+)	MTC-IR-P	BLK M	$14	MTC-IR-S	BLK M	$16
Constantan (–)	MTC-CO-P	YEL N	17	MTC-CO-S	YEL N	24
Copper (+)	MTC-CU-P	RED C	14	MTC-CU-S	RED C	16
Chromel (+)	MTC-CH-P	WHT P	17	MTC-CH-S	WHT P	24
Alumel (–)	MTC-AL-P	GRN R	17	MTC-AL-S	GRN R	24
*Gold Plated (Uncompensated)	MTC-Au-P	Color Bands RED, YEL, BRN	.75	MTC-Au-S	Color Bands RED, BLU, BLK	1.25
Sealing Plug	MTC-HP		.50	MTC-HP		.50

For use with non-thermocouple wire in same body.

Material	Thermocouple Type (ANSI Symbol)
Iron/Constantan	J
Chromel/Alumel	K
Copper/Constantan	T
Chromel/Constantan	E

ssembly Tools

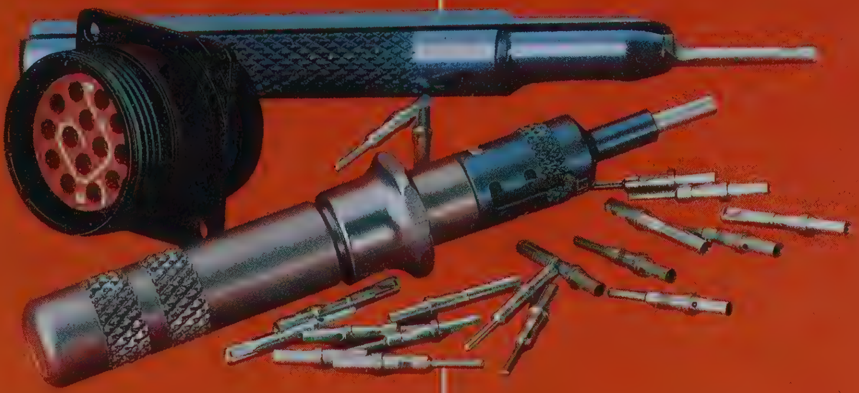
Heavy Duty Crimping Tool **MTC-CT $142**



Ratchet Action Easy-to-Use!
Specially designed MS standard crimping tool MUST be used to properly crimp wires to pins and sockets. Ratchet action ensures a complete crimp every time.

Removal Tool **MTC-RT $35**

Insertion Tool **MTC-IT $8**



How to Order

Specify Connector Body, Contacts and Backshell.

Example: Cord to Cord connectors for 6 type J (Iron-Constantan) thermocouple circuits (pairs).

Male Connector Assembly
1. Body: MTC-12-MC
2. Pins: (+) Pos. Alloy MTC-IR-P
   (–) Neg. Alloy MTC-CO-P
3. Backshell: MTC-12-SHL

Female Connector Assembly
1. Body: MTC-12-FC
2. Sockets: (+) Pos. Alloy MTC-IR-S
   (–) Neg. Alloy MTC-CO-S
3. Backshell: MTC-12-SHL

Important Notes

1. MS Standard Assembly Tools are required to properly crimp and assemble connectors. Order with first purchase.
2. Match Pins and sockets to Thermocouple Alloys
   Example: A 12 cavity connector carries 6 thermocouple circuits (pairs) requiring: 6 positive alloy pins or sockets and 6 negative alloy pins or sockets per body.
3. Order bodies in Mating Pairs
   Style MC mates with style FF.
   Style MC mates with style FC.
4. Backshell Cable Clamps are recommended with each cord style connector.

Round Hole Panel Jacks

FRONT MOUNT HARDWARE INCLUDED

1⅛" Square Bezel

Rear View
Nut Included
1⅛" Dia. Bezel

Fast!
OFF-THE-SHELF DELIVERY

Standard Connectors

Alloy Code	Color	Square Face	Round Face	Price Each
K	Yellow	RSJ-K-S	RSJ-K-R	$2.25
T	Blue	RSJ-T-S	RSJ-T-R	
J	Black	RSJ-J-S	RSJ-J-R	
E	Purple	RSJ-E-S	RSJ-E-R	
R/S	Green	RSJ-R/S-S	RSJ-R/S-R	
U	White	RSJ-U-S	RSJ-U-R	

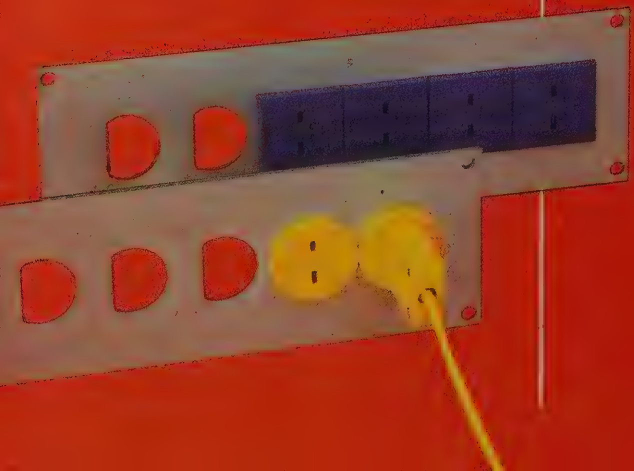
- **Standard size for use with OST, OGP, NOX and other standard size male connectors**
- **Miniature size for use with SMP, NMP and other miniature size male connectors**
- **Mounts in round or "D" punch holes**
- **Square or round bezel to match your panel components**
- **Heavy duty glass filled nylon**
- **Polarity keyed**
- **Color coded**
- **No filing required**

EASY INSTALLATION

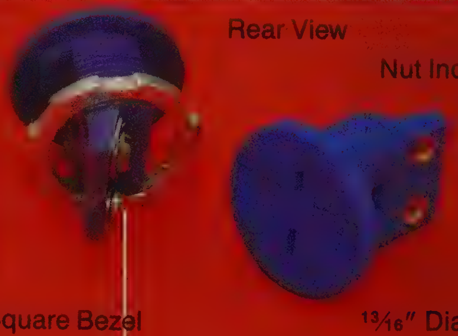
No special tooling is required for installation. Just drill or punch a round hole in your panel and tighten the supplied nut. Ideal for single circuit applications where the connector must blend with existing instrumentation. Thermocouple circuits can be added to existing panels with a minmum interruption of operation. A choice of either square or round face is available to match the design lines of your installation. Thermocouple grade alloys used to form the contacts preserve the accuracy of the circuit even in changing ambient temperatures. **See page G-50 for panel punches and saws.**

Miniature Connectors

Alloy Code	Color	Square Face	Round Face	Price Each
K	Yellow	RMJ-K-S	RMJ-K-R	$1.95
T	Blue	RMJ-T-S	RMJ-T-R	
J	Black	RMJ-J-S	RMJ-J-R	
E	Purple	RMJ-E-S	RMJ-E-R	
R/S	Green	RMJ-R/S-S	RMJ-R/S-R	
U	White	RMJ-U-S	RMJ-U-R	



13/16" Square Bezel



13/16" Dia. Bezel

Bezel Strip Mounting
For SMP Connectors

esigner Panel Mount for re-wired SMP Connectors

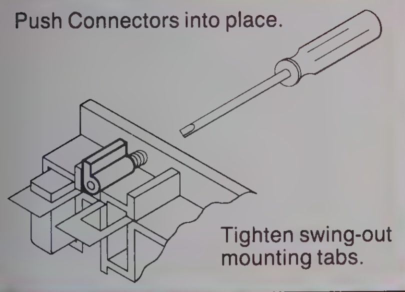
- Up to 12 Positions
- Designer Appearance
- Lock Tab Mounting
- One Panel Opening

NEW LOW PRICES

FF-THE-SHELF DELIVERY

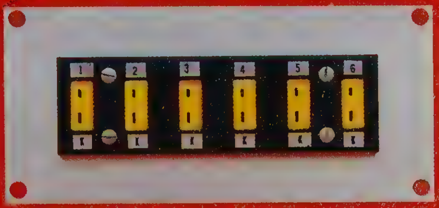
EASY-TO-USE

Push Connectors into place.



asy to install connector—
ust push into place.
asy to install—easy to remove.

Unique Design—
No Mounting Hardware



The OMEGA Bezel Strip system mounts in a single rectangular cutout in your panel. The textured black finish accents the ANSI color coded connectors. Pre-wired SMP connectors can be individually inserted and removed from the mounting strip.

IN STOCK FOR IMMEDIATE DELIVERY.

Number of Positions	Cutout W″ × H″	Part Number	Price
2	1.21 × 1.00	MBS-02	$2.00
3	1.90 × 1.00	MBS-03	2.50
4	2.59 × 1.00	MBS-04	3.00
5	3.27 × 1.00	MBS-05	3.50
6	3.96 × 1.00	MBS-06	4.00
7	4.65 × 1.00	MBS-07	4.50
8	5.34 × 1.00	MBS-08	5.00
9	6.03 × 1.00	MBS-09	5.50
10	6.71 × 1.00	MBS-10	6.00
12	8.09 × 1.00	MBS-12	7.00

NOTE: SMP Connectors are not included.

Quantity Discounts

1 - 10	**Net**
11 - 24	**10%**
25 - 49	**15%**
50 - 99	**20%**
100 - 999	**25%**
1000 and over	**Consult Sales Department**

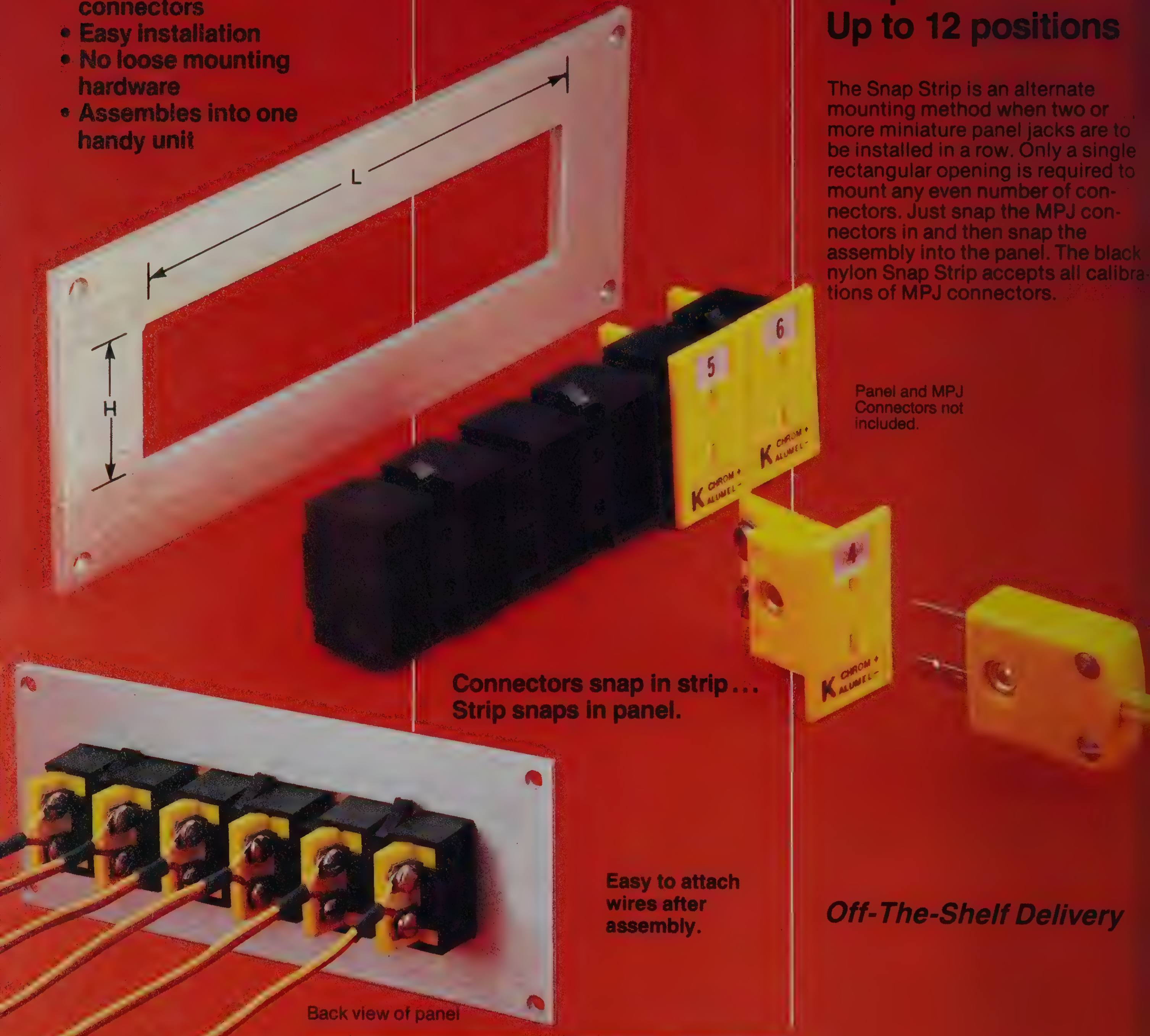
Snap Strips

For Mounting Miniature MPJ Connectors

- One cutout fits up to 12 connectors
- Easy installation
- No loose mounting hardware
- Assembles into one handy unit

Snap in!
Up to 12 positions

The Snap Strip is an alternate mounting method when two or more miniature panel jacks are to be installed in a row. Only a single rectangular opening is required to mount any even number of connectors. Just snap the MPJ connectors in and then snap the assembly into the panel. The black nylon Snap Strip accepts all calibrations of MPJ connectors.



Panel and MPJ Connectors not included.

Connectors snap in strip . . . Strip snaps in panel.

Easy to attach wires after assembly.

Back view of panel

Off-The-Shelf Delivery

Number of Positions	Cutout H″ x L″	Catalog Number	Price
2	0.793 x 0.98	MSS-02	$1
4	0.793 x 2.10	MSS-04	2
6	0.793 x 3.23	MSS-06	3
8	0.793 x 4.35	MSS-08	4
10	0.793 x 5.48	MSS-10	5
12	0.793 x 6.60	MSS-12	6

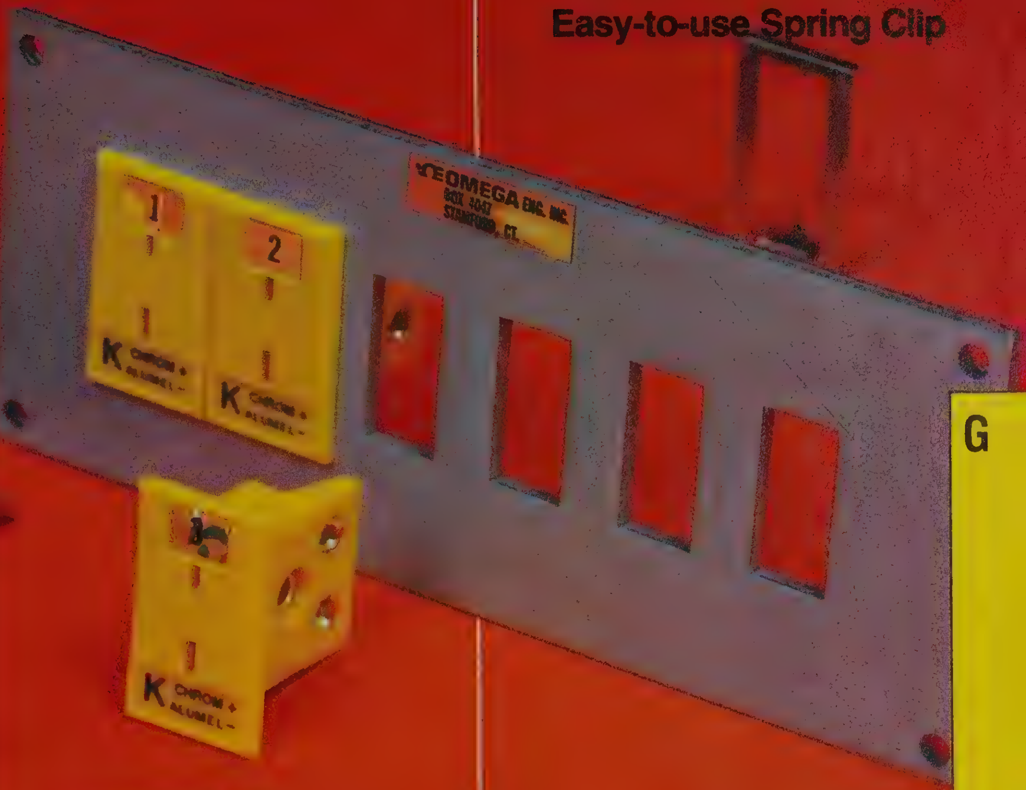
Quantity Discounts

1 - 10	**Net**
11 - 24	**10%**
25 - 49	**15%**
50 - 99	**20%**
100 - 999	**25%**
1000 and over	**Consult Sales Department**

Panel Jacks
Miniature

Compact Size
Easy Mount
Accessible Terminal Screws
Color Coded
Accepts SMP or NMP Male Connectors

Off-The-Shelf Delivery


Easy-to-use Spring Clip

Spring Clip included
K CHROM + ALUMEL –

Mates with Miniature Connectors

The MPJ Miniature Panel Jack requires less than half of the panel area required by the standard size version. A simple push-on clip is all that is required to retain the connector in a rectangular cutout or the optional MSS snap strip can be used to mount a row. Angled terminal screws allow wiring to be done after panel assembly.

0.318″ × 0.656″ Cutout Required
0.562″ Centers Horizontally
0.938″ Centers Row to Row Minimum

Alloy Code*	Type of Thermocouple Used With Connector	Compensating Alloy Used in Connector +	Compensating Alloy Used in Connector –	Shell Color	Catalog Number (Female)	Price of Jack
K	Chromel-Alumel	Chromel	Alumel	Yellow	MPJ-K-F	$2.25
T	Copper-Constantan	Copper	Constantan	Blue	MPJ-T-F	2.25
J	Iron-Constantan	Iron	Constantan	Black	MPJ-J-F	2.25
E	Chromel-Constantan	Chromel	Constantan	Purple	MPJ-E-F	2.25
R	Pt-Pt/13%Rh	Copper	Alloy #11	Green	MPJ-R-F	2.25
S	Pt-Pt/10%Rh	Copper	Alloy #11	Green	MPJ-S-F	2.25
G	W-W/26%Re	Alloy #200	Alloy #226	Red	MPJ-G-F	2.25
C	W/5%Re-W/26%Re	Alloy #405	Alloy #426	Red	MPJ-C-F	2.25
D	W/3%Re-W/25%Re	Alloy #203	Alloy #225	Red	MPJ-D-F	2.25
U	Uncompensated	Copper	Copper	White	MPJ-U-F	2.25

Additional spring clips 5¢ each.

Quantity Discounts

Quantity	Discount
1 - 10	**Net**
11 - 24	**10%**
25 - 49	**15%**
50 - 99	**20%**
100 - 999	**25%**
1000 and over	**Consult Sales Department**

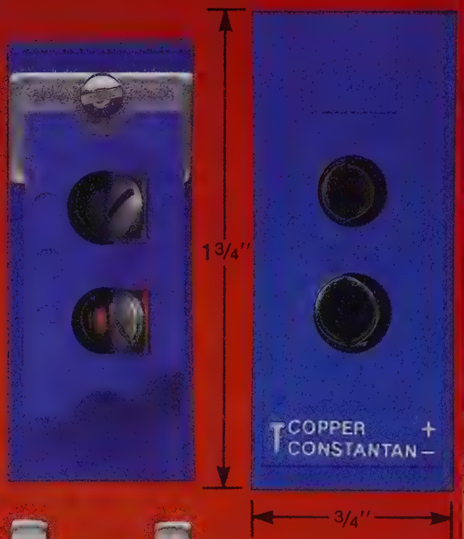
* K, T, J, E, R, S & B are ANSI designations.
NOTE: Type U (Uncompensated) connectors are used with type B thermocouples (Platinum/6% Rhodium-Platinum 30% Rhodium).

Panel Jacks
Color coded

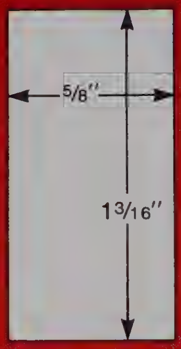
NEW LOW PRICES

- **Heavy Duty Construction**
- **Easy Installation**
- **Flexibility**
- **Labeled for Identification**
- **Decorative—Enhances any Instrument**

Type JP will accommodate wires up to 14 AWG. Alloys of the inserts match ANSI thermocouple grade calibrations.



K CHROMEL +
ALUMEL –



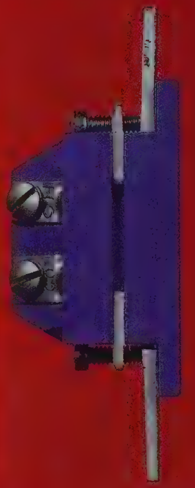
Shown larger than actual size

OMEGA's Panel Jacks contain two female, collet-type, spring loaded connectors that will accept any standard male thermocouple connector. The Panel Jacks are molded of high impact, glass filled nylon and are numbered and labeled as well as color coded.

Rugged Securing Clip

Off-The-Shelf Delivery

Alloy Code*	Type of Thermocouple Used With Connector	Compensating Alloy Used in Connector +	Compensating Alloy Used in Connector –	Shell Color	Catalog Number (Female)	Price of Jack
K	Chromel-Alumel	Chromel	Alumel	Yellow	JP-K-F	$ 4.50
T	Copper-Constantan	Copper	Constantan	Blue	JP-T-F	4.50
J	Iron-Constantan	Iron	Constantan	Black	JP-J-F	4.50
E	Chromel-Constantan	Chromel	Constantan	Purple	JP-E-F	4.50
R	Pt-Pt/13%Rh	Copper	Alloy #11	Green	JP-R-F	4.50
S	Pt-Pt/10%Rh	Copper	Alloy #11	Green	JP-S-F	4.50
G	W-W/26%Re	Alloy #200	Alloy #226	Red	JP-G-F	11.00
C	W/5%Re-W/26%Re	Alloy #405	Alloy #426	Red	JP-C-F	11.00
D	W/3%Re-W/25%Re	Alloy #203	Alloy #225	Red	JP-D-F	11.00
U	Uncompensated	Copper	Copper	White	JP-U-F	4.50



*K, T, J, E, R, S & B are ANSI designations.

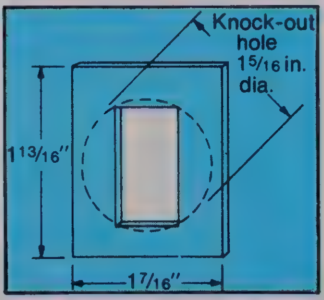
NOTE: Type U (Uncompensated) connectors are used with type B thermocouples (Platinum/6% Rhodium-Platinum 30% Rhodium).

Quantity Discounts

Quantity	Discount
1 - 10	**Net**
11 - 24	**10%**
25 - 49	**15%**
50 - 99	**20%**
100 - 999	**25%**
1000 and over	**Consult Factory**

Panel Mounting Adaptor Plates
. . . for mounting a single panel jack in a round knock-out hole

Catalog No. RJACL



$2 each

Mounting plate used with OMEGA type JP decorator styled, color coded panel jacks adapts them for mounting as single circuit jack in control panel or instrument case. Simplifies mounting, and holds the connector in place tightly. Covers 1⁵⁄₁₆″ diameter knock-out hole. All adaptor plates are made of 0.030″ (0.76 mm) nickel-plated steel. Price includes all screws and mounting hardware.

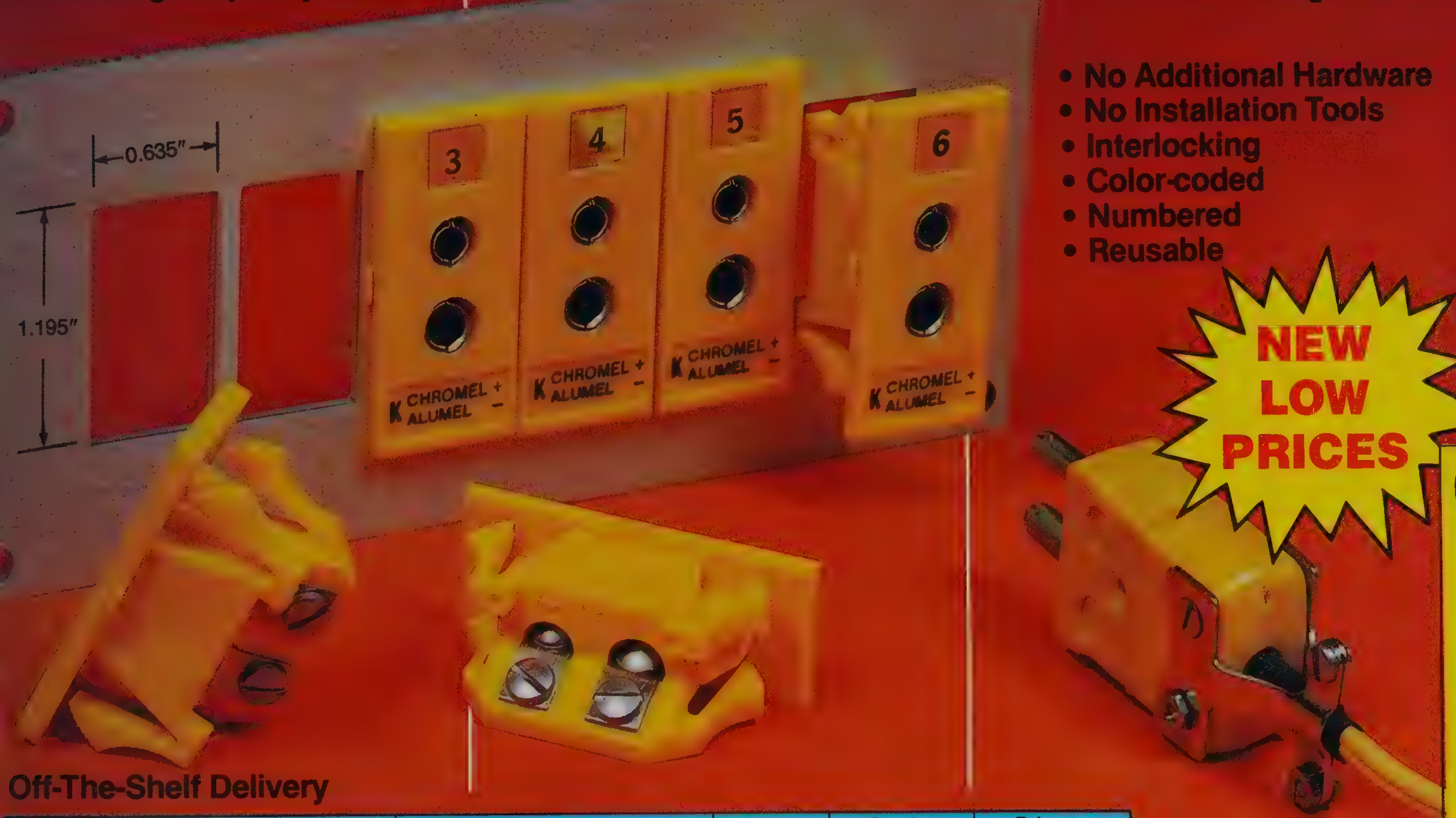
Panel Jacks

Snap-in

elf-securing design is the ultimate
n mounting simplicity.

- No Additional Hardware
- No Installation Tools
- Interlocking
- Color-coded
- Numbered
- Reusable

NEW LOW PRICES



HEAVY DUTY

Off-The-Shelf Delivery

Alloy Code*	Type of Thermocouple Used With Connector	Compensating Alloy Used in Connector +	Compensating Alloy Used in Connector −	Shell Color	Catalog Number (Female)	Price of Jack
K	Chromel-Alumel	Chromel	Alumel	Yellow	SPJ-K-F	$ 4.25
T	Copper-Constantan	Copper	Constantan	Blue	SPJ-T-F	4.25
J	Iron-Constantan	Iron	Constantan	Black	SPJ-J-F	4.25
E	Chromel-Constantan	Chromel	Constantan	Purple	SPJ-E-F	4.25
R	Pt-Pt/13%Rh	Copper	Alloy #11	Green	SPJ-R-F	4.25
S	Pt-Pt/10%Rh	Copper	Alloy #11	Green	SPJ-S-F	4.25
G	W-W/26%Re	Alloy #200	Alloy #226	Red	SPJ-G-F	11.00
C	W/5%Re-W/26%Re	Alloy #405	Alloy #426	Red	SPJ-C-F	11.00
D	W/3%Re-W/25%Re	Alloy #203	Alloy #225	Red	SPJ-D-F	11.00
U	Uncompensated	Copper	Copper	White	SPJ-U-F	4.25

*K, T, J, E, R, S & B are ANSI designations.

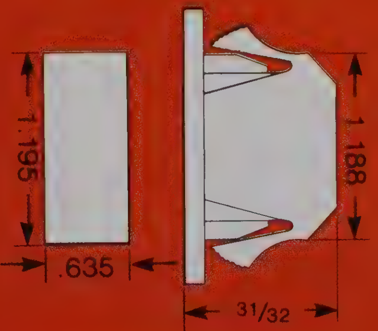
NOTE: Type U (Uncompensated) connectors are used with type B thermocouples (Platinum/6% Rhodium-Platinum 30% Rhodium).

Quantity Discounts

Quantity	Discount
1 - 10	Net
11 - 24	10%
25 - 49	15%
50 - 99	20%
100 - 999	25%
1000 and over	Consult Factory

Mounting hardware has been eliminated in the SPJ style Panel Jacks by including the retaining spring clips as a part of the body design. A small tab and notch are provided to maintain straight, even rows without the need for precision machining.

The SPJ color coded nylon connectors accept any standard size male thermocouple connector and are available in all ANSI calibrations as well as tungsten alloys.



CUSTOM MARKING AVAILABLE. CONSULT SALES DEPARTMENT FOR PRICES AND QUANTITIES.

Removal Tool

Catalog Number SIRT-1 $15

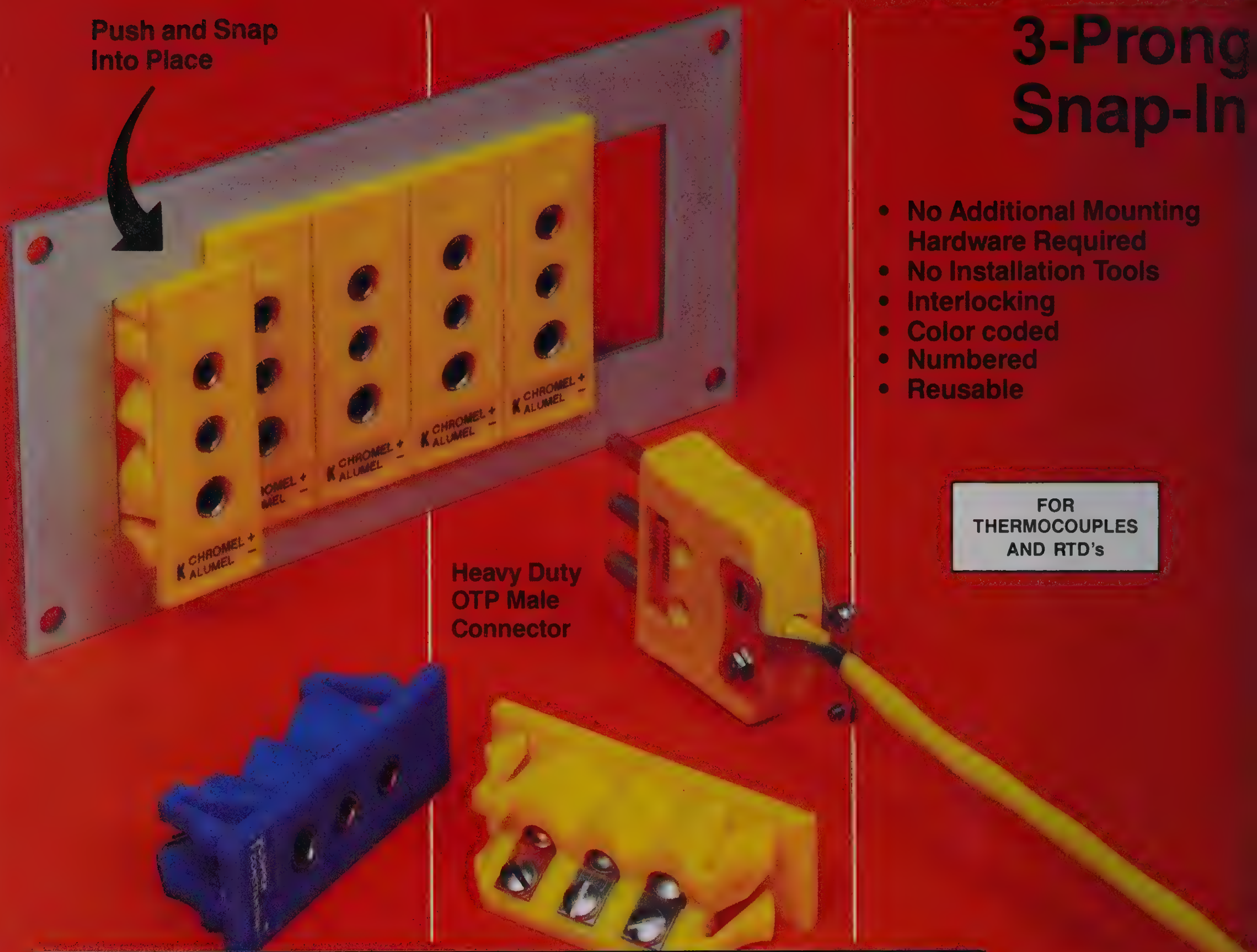
For the large volume user that requires the ability to quickly remove installed connectors, the SIRT-1 removal tool is available. Operating easily even in densely packed panels, the tool compresses all spring clips together allowing the SPJ to be pushed out of the panel from the rear.

Panel Jacks

3-Prong Snap-In

- No Additional Mounting Hardware Required
- No Installation Tools
- Interlocking
- Color coded
- Numbered
- Reusable

FOR THERMOCOUPLES AND RTD's


Push and Snap Into Place

Heavy Duty OTP Male Connector

Alloy Code*	Type of Thermocouple Used With Connector	Compensating Alloy Used in Connector		Shell Color	Catalog Number (Female)	Price of Jack
		+	−			
K	Chromel-Alumel	Chromel	Alumel	Yellow	TPJ-K-F	$4.50
T	Copper-Constantan	Copper	Constantan	Blue	TPJ-T-F	4.50
J	Iron-Constantan	Iron	Constantan	Black	TPJ-J-F	4.50
E	Chromel-Constantan	Chromel	Constantan	Purple	TPJ-E-F	4.50
U	Uncompensated	Copper	Copper	White	TPJ-U-F	4.50

Quantity Discounts

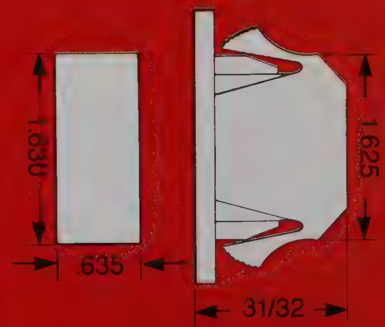
1 - 10	**Net**
11 - 24	**10%**
25 - 49	**15%**
50 - 99	**20%**
100 - 999	**25%**
1000 and over	**Consult Factory**

*K, T, J, & E are ANSI designations.

NOTE: Type U (Uncompensated) connectors are used with type B Thermocouples (Platinum/6% Rhodium-Platinum 30% Rhodium).

Mounting hardware has been eliminated in the TPJ style Panel Jacks by including the retaining spring clips as a part of the body design. A small tab and notch are provided to maintain straight, even rows without the need for precision machining.

The TPJ color coded nylon connectors accept any male thermocouple connector and are available in ANSI calibrations J, K, T, & E. Also available in uncompensated, alloy code U, for RTDs and Thermistors.



CUSTOMER MARKING AVAILABLE. CONSULT SALES DEPARTMENT FOR PRICES AND QUANTITIES.

Removal Tool

Catalog Number SIRT-2 $15

For the large volume user that requires the ability to quickly remove installed connectors, the SIRT-2 removal tool is available. Operating easily even in densely packed panels, the tool compresses all spring clips together allowing the TPJ to be pushed out of the panel from the rear.

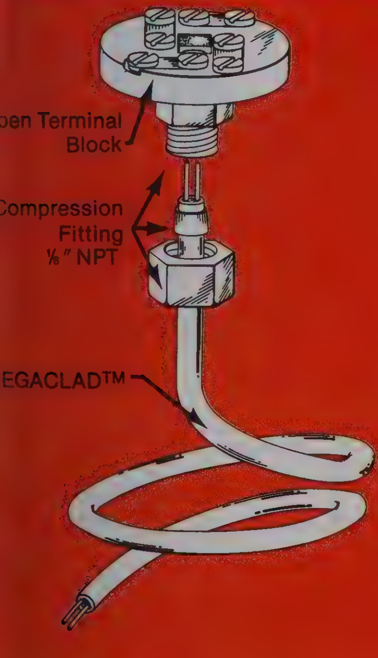
Round Terminal Blocks

- **ANSI Color-coded**
- **Single or Dual Elements**
- **Terminal Block Rated to 425°F (218°C)**
- **Fits ¹⁄₁₆″ to ¼″ Probes and Sheaths**
- **T/C Alloy or Copper Terminal Lugs**

OMEGA's Color-coded "CH" Terminal Blocks are designed to fit all metal-sheathed cable or probes between ¹⁄₁₆″ and ¼″ diameter. Their exposed terminals with large binding head screws provide fast, easy terminations. They are available with thermocouple alloy or copper terminal lugs to ensure error free connections.

Heavy-duty glass-filled nylon construction allows a 425°F (218°C) maximum temperature rating. The "CH" Terminal Blocks use a ⅛″ NPT compression fitting to adapt to almost any diameter probe or cable. Suitable compression fittings are the OMEGA BRLK and SSLK series shown in the Table Below. Select CH62, CH63, or CH64 to terminate OMEGACLAD™ and other mineral-insulated cable depending upon the number of terminals required. See diagram for installation.

Terminates Metal-sheathed Cable



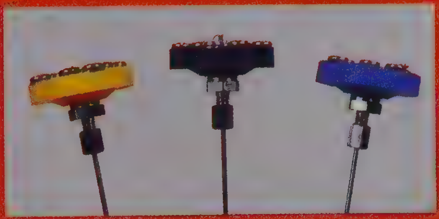
HOW TO ORDER:

Model No.	Mounting	No. Terminals	Price
CH62-☐	⅛″ NPT*	2	$3.25
CH63-☐	⅛″ NPT*	3	3.50
CH64-☐	⅛″ NPT*	4	3.75

☐ = Insert K, J, T, E, or S for thermocouple calibration desired, or Cu for uncompensated lugs for RTD use.

* See table below to select pressure fitting according to cable or probe diameter.

OMEGALOK™ Compression Fittings



OMEGALOK™ compression fittings are available in brass and stainless steel to meet the most severe environmental conditions. The "CH" terminal blocks require a ⅛″ NPT on the fitting (see chart). For the complete line of compression fittings refer to page 40.

Compression fittings for		Price	
Probe Diameter	**Part No.**	**Brass**	**SS**
¹⁄₁₆″	☐ LK-116-18	$4.75	$12.00
⅛″	☐ LK-18-18	3.00	8.00
³⁄₁₆″	☐ LK-316-18	3.00	8.00
¼″	☐ LK-14-18	3.00	8.00

☐ = Insert BR for brass or SS for stainless steel material.

Miniature Connectors
For RTD's and Thermistors
Series "T"

OMEGA
PLATINUM THERMOMETER
450 APT
HOLD
OFF
1°
0.1°
°F
°C
TEMPERATURE INDICATOR

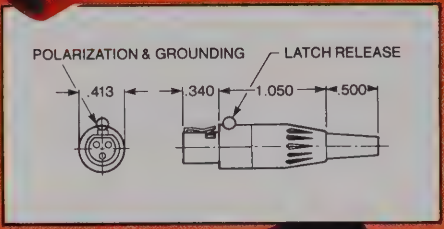
- Latch Lock Mechanism
- Polarized by Mechanical Key
- Three and Four Pin Models
- Three and Four Wire RTD Applications
- Well Suited for Most Instrumentation Uses
- Both Internal Strain Relief and External Flexure Relief

OMEGA introduces its new "T" Series Miniature Instrumentation Connectors. OMEGA "T" Series Connectors are particularly well suited for both three and four wire RTD sensors as well as other types of instrumentation where copper-type lead wire is used. OMEGA "T" Connectors are not recommended for use with thermocouples which require connectors with special compensating alloys in their construction.

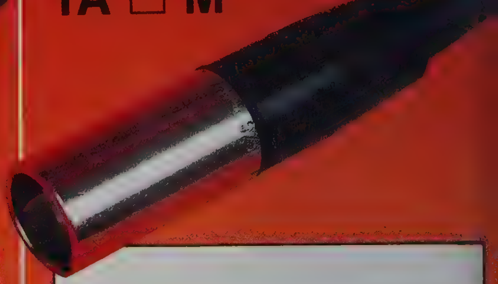
The Series "T" Connector family includes both a male (Model TA-M) and female (Model TA-F) cord plug, as well as two panel/bulkhead receptacles — one male (Model TB-M), the other female (TB-F). All four items are available in both three or four pin contact construction. A trim plate, Model TYEF, is available for the female panel receptacle.

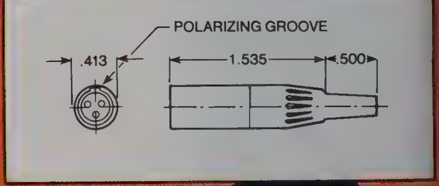
Both male and female cord plugs are offered in two styles: with flexure relief, which accepts up to 0.115″ (2.9 mm) cable diameter, or without flexure relief, which accepts up to 0.175″ (4.4 mm) cable diameter (add "L" suffix to Cat. No.). "L" style must be ordered when used with OMEGA's Retractable Sensor Cable (RSC). Connections are made on all styles by solder terminals.

TA ☐ F

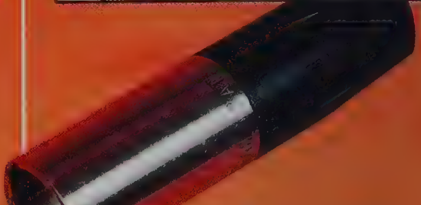

POLARIZATION & GROUNDING
LATCH RELEASE
.413
.340
1.050
.500

TA ☐ M

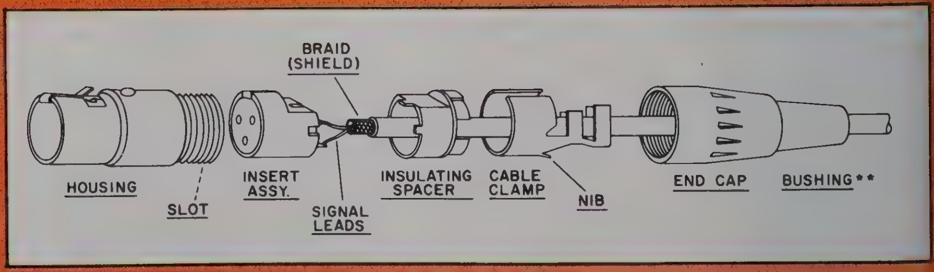



POLARIZING GROOVE
.413
1.535
.500

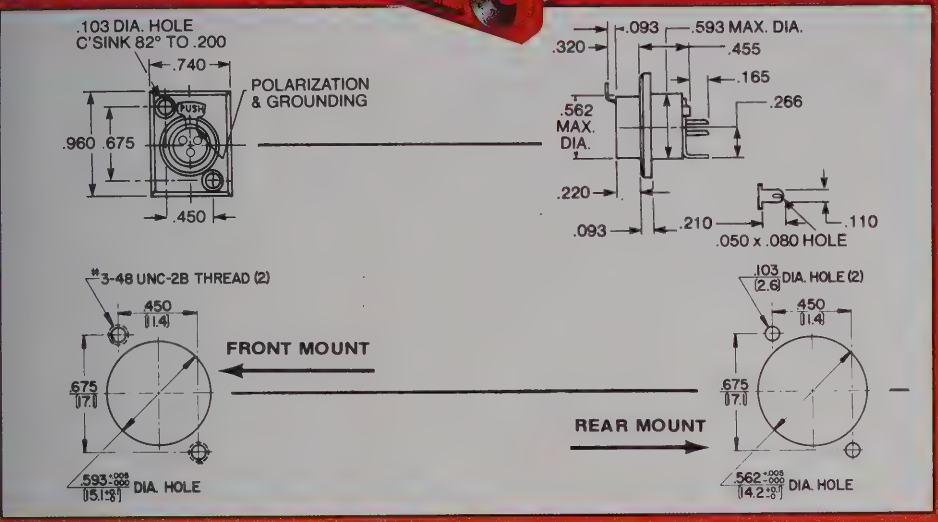
TA ☐ FL

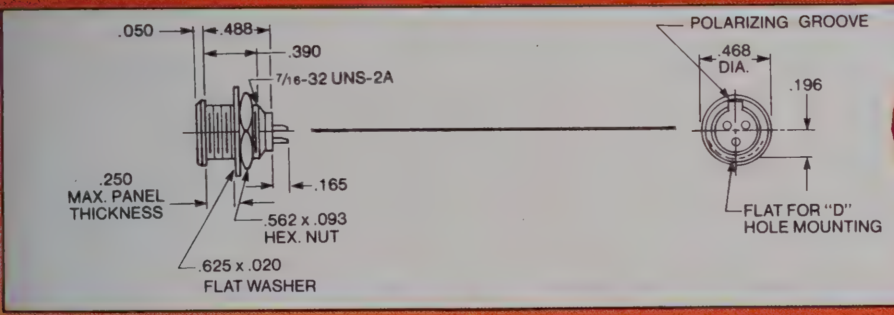


TA ☐ ML


BRAID (SHIELD)
HOUSING
SLOT
INSERT ASSY.
SIGNAL LEADS
INSULATING SPACER
CABLE CLAMP
NIB
END CAP
BUSHING**

RECEPTACLE
FEMALE
TY □ F

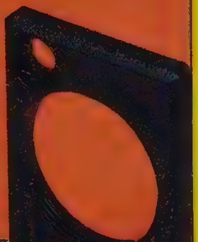

.103 DIA. HOLE
C'SINK 82° TO .200
.740
POLARIZATION
& GROUNDING
PUSH
.960
.675
.450
.320
.093
.593 MAX. DIA.
.455
.165
.266
.562
MAX.
DIA.
.220
.093
.210
.110
.050 x .080 HOLE
#3-48 UNC-2B THREAD (2)
.450
[11.4]
FRONT MOUNT
.675
[17.1]
.593 +.005 -.000
[15.1 +.1 -0]
DIA. HOLE
.103
[2.6]
DIA. HOLE (2)
.450
[11.4]
.675
[17.1]
REAR MOUNT
.562 +.005 -.000
[14.2 +.1 -0]
DIA. HOLE

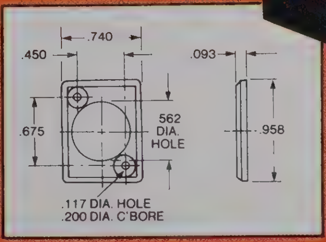

.050
.488
.390
7/16-32 UNS-2A
.250
MAX. PANEL
THICKNESS
.165
.562 x .093
HEX. NUT
.625 x .020
FLAT WASHER
POLARIZING GROOVE
.468
DIA.
.196
FLAT FOR "D"
HOLE MOUNTING

RECEPTACLE
MALE
TB □ M

Item	Male/Female	Max. Cable Dia. (inches)	No. Pins at Contact	Cat. No.	Price
Cord Plug	Male	0.115	3	TA3M	$4.20
		0.115	4	TA4M	4.35
	Female	0.115	3	TA3F	4.65
		0.115	4	TA4F	4.85
Cord Plug	Male	0.175	3	TA3ML	4.20
		0.175	4	TA4ML	4.35
	Female	0.175	3	TA3FL	4.65
		0.175	4	TA4FL	4.85
Receptacle	Male	—	3	TB3M	4.30
			4	TB4M	4.50
	Female	—	3	TY3F	5.30
			4	TY4F	5.50
Trim Plate	—	—	—	TYEF-02	.50

TYEF-02
TRIM
PLATES
$.50




.740
.450
.093
.675
562
DIA.
HOLE
.958
.117 DIA. HOLE
.200 DIA. C'BORE

Rotary Selector Switches

OMEGA ENGINEERING INC.
OMEGA ENGINEERING INC.
OMEGA ENGINEERING INC.

OPTIONAL
PISTOL
GRIPS

- **2 or 3 Poles**
- **2 to 40 Positions**
- **Round or Pistol Grip Handles**

OMEGA ENGINEERING's two and three pole selector switches are designed to provide isothermal, low-resistance switching in your temperature measuring circuits. Two to 40 positions in addition to "Off" are available in a designer-styled, unbreakable Noryl* case.

The isothermal design minimizes temperature gradients between the input and output thermocouple wiring to avoid the generation of thermal emf's that add error to your thermocouple temperature measuring circuit. Temperature-sensitive resistance transducers such as RTD's and thermistors can be switched with confidence knowing that the low contact resistance will not add any appreciable error to the measurement.

Insulation Resistance:
20 megohms at 300 Volts dc

Contact Resistance:
0.004 ohms or less

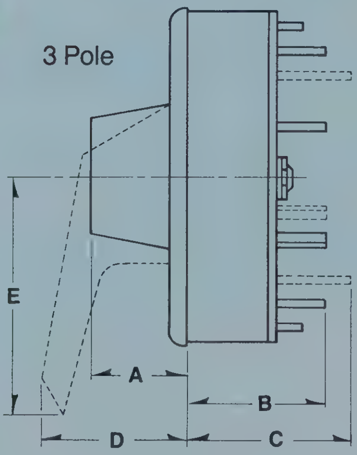
Pistol grip handle retrofit kit is available – Just specify OSW-PG and switch size

Price $10

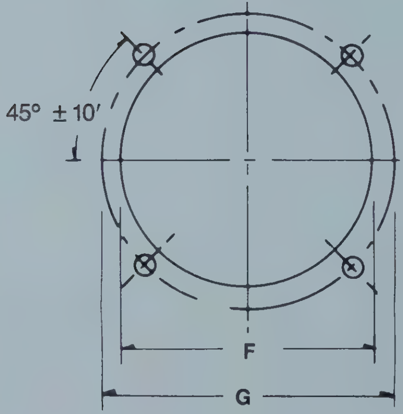
*Trademark of General Electric

2 Pole

3 Pole



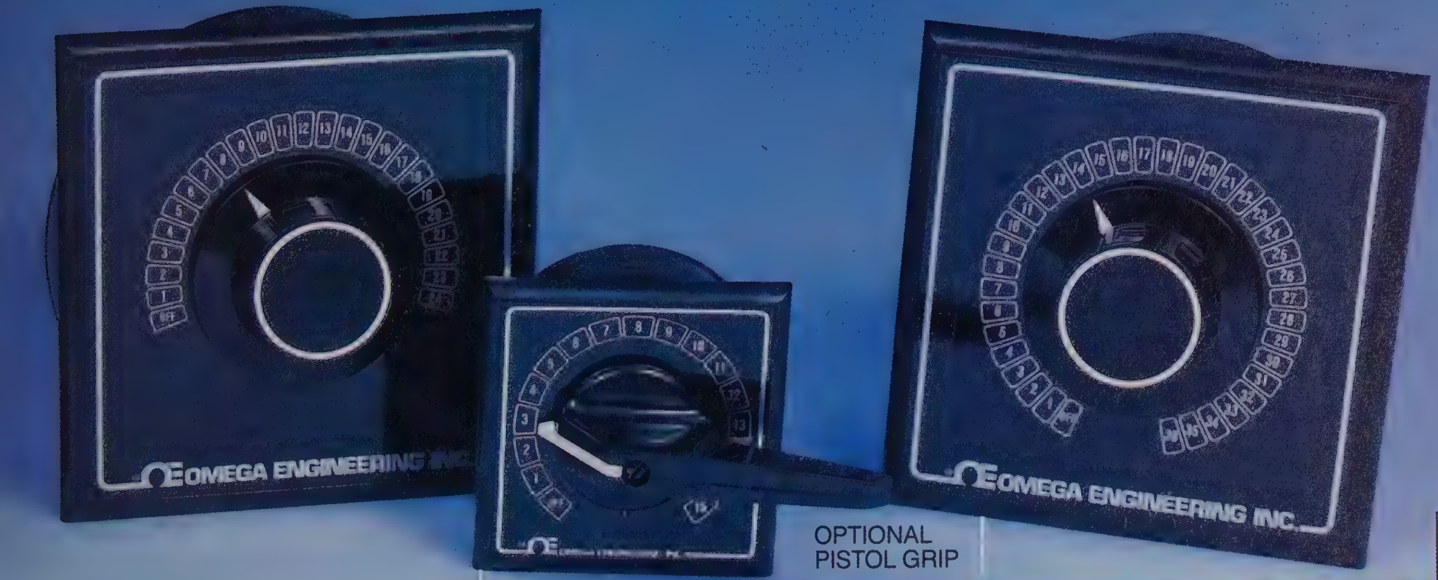
HOLE PATTERN



No. 18 (0.1695) DRILL
4 HOLES EQUALLY SPACED

Switch	Dim. A	Dim B	Dim. C	Dim. D	Dim. E	Bezel	Dim. F	Dim G
3″	1⅛″	2⅛″	2 7⁄16″	1¾″	2⅝″	3¼″	3.187″	3.710″
5″	1½″	2⅛″	2 7⁄16″	2 5⁄16″	3⅝″	5¼″	5.187″	6.540″

For Thermocouple, RTD, and Thermistor Circuits



OPTIONAL PISTOL GRIP

The terminals are clearly marked on the rear of the switch to avoid any confusion in wiring. Included with the switch is provision to either short or leave the circuit open when in the "Off" position. This allows the user to match the characteristics of the readout device in all channel positions; each pole is fully isolated. Silver plating of both the wiper and contacts, combined with a low pressure self-cleaning wiping action, assures trouble-free, long life.

For the two pole version, the 2 to 20 position switches come in the 3″ diameter housing and the 24 to 40 position models have a 5″ diameter housing. All of the three pole versions have a 5″ diameter housing.

Both switch sizes are available with either the standard round knob, or a pistol-grip handle. The pistol-grip handle is especially recommended when the switch position must be seen from a distance or the user is wearing gloves.

NOW! 3 POLES FOR RTDs AND THERMISTORS

Quantity Discount	
1-10	Net
11-24	10%
25-100	20%
101-500	30%
501-1000	40%
1001-5000	50%

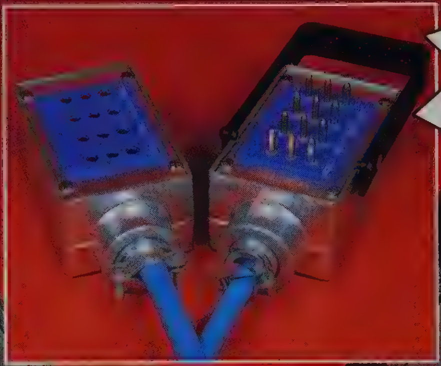
No. Poles	Number Positions	Contact Action	Size	Round Knob Part No.	Round Knob Price	Pistol Grip Part No.	Pistol Grip Price
2 POLE	2	Break Before Make	3″	OSW3 - 2	$ 85.00	OSW3 - 2-PG	$ 91.50
	3			OSW3 - 3	87.00	OSW3 - 3-PG	93.50
	4			OSW3 - 4	89.00	OSW3 - 4-PG	95.50
	5			OSW3 - 5	91.00	OSW3 - 5-PG	97.50
	6			OSW3 - 6	93.00	OSW3 - 6-PG	99.50
	8			OSW3 - 8	97.00	OSW3 - 8-PG	103.50
	9			OSW3 - 9	99.00	OSW3 - 9-PG	105.50
	10			OSW3-10	101.00	OSW3-10-PG	107.50
	12	Make Before Break	3″	OSW3-12	105.00	OSW3-12-PG	111.50
	14			OSW3-14	109.00	OSW3-14-PG	115.50
	16			OSW3-16	113.00	OSW3-16-PG	119.50
	18			OSW3-18	117.00	OSW3-18-PG	123.50
	20			OSW3-20	121.00	OSW3-20-PG	127.50
	24		5″	OSW5-24	129.00	OSW5-24-PG	135.50
	28			OSW5-28	137.00	OSW5-28-PG	143.50
	30			OSW5-30	141.00	OSW5-30-PG	147.50
	32			OSW5-32	145.00	OSW5-32-PG	151.50
	36			OSW5-36	153.00	OSW5-36-PG	159.50
	40			OSW5-40	165.00	OSW5-40-PG	171.50
3 POLE	6	Make Before Break	5″	OSWT - 6	99.00	OSWT - 6-PG	105.50
	10			OSWT-10	111.00	OSWT-10-PG	117.50
	12			OSWT-12	117.00	OSWT-12-PG	123.50
	18			OSWT-18	135.00	OSWT-18-PG	141.50
	20			OSWT-20	141.00	OSWT-20-PG	147.50
	24			OSWT-24	150.00	OSWT-24-PG	156.50
	28			OSWT-28	162.00	OSWT-28-PG	168.50
	30			OSWT-30	168.00	OSWT-30-PG	174.50
	32			OSWT-32	174.00	OSWT-32-PG	180.50
	36			OSWT-36	186.00	OSWT-36-PG	192.50
	40			OSWT-40	198.00	OSWT-40-PG	204.50

Jack Panel Conduit Box

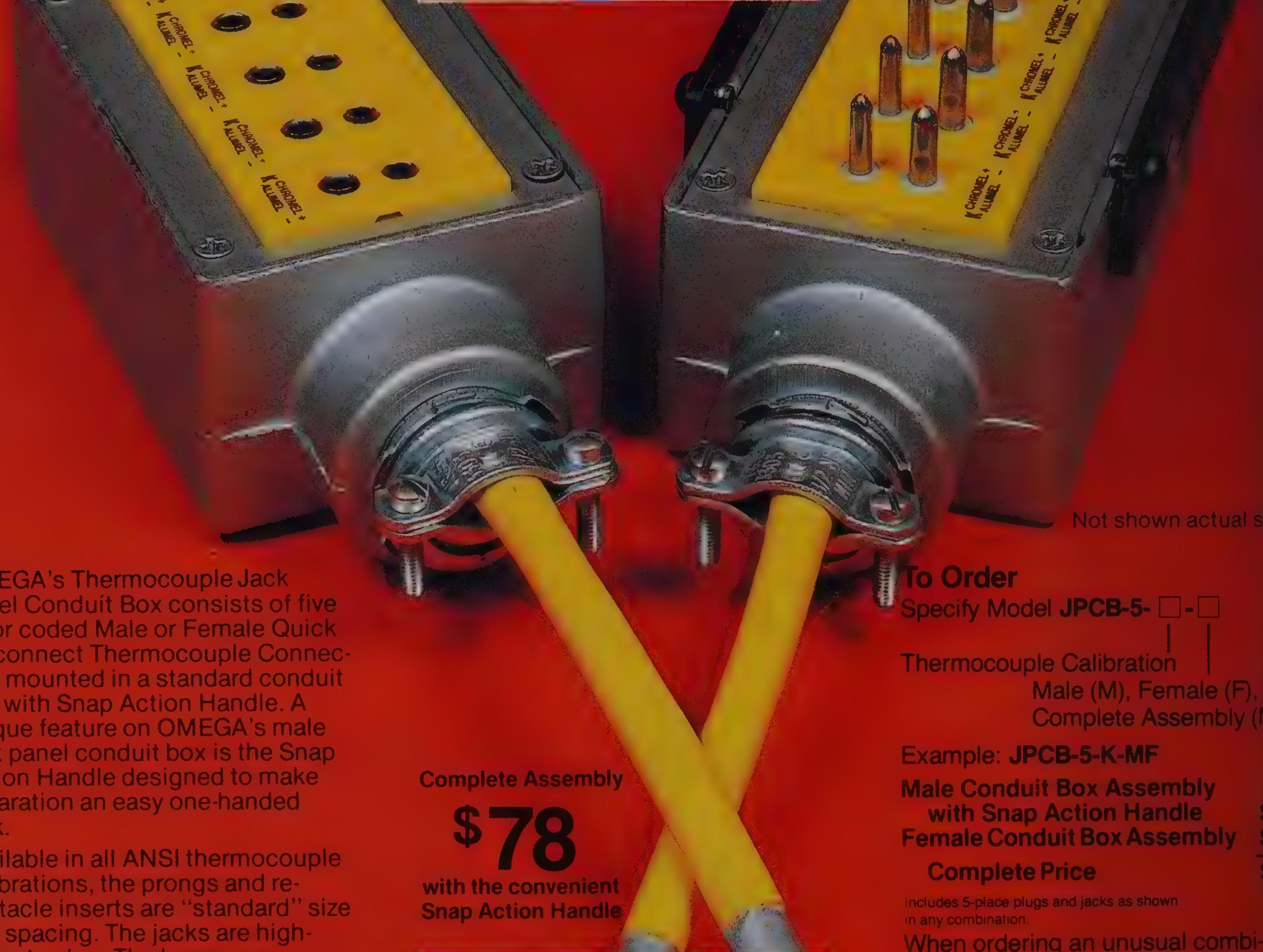
Quick Disconnect

Color coded

NOW AVAILABLE!
Three Conductor TPJ Connectors (4 only) can be supplied in place of the two conductor style. Simply replace the JPCB-5-Prefix with TJPCB-4. The price does not change. TJPCB-4-T-MF is shown.



Now Available with 3-Pole Connectors, Too!



Not shown actual size

OMEGA's Thermocouple Jack Panel Conduit Box consists of five color coded Male or Female Quick Disconnect Thermocouple Connectors mounted in a standard conduit box with Snap Action Handle. A unique feature on OMEGA's male jack panel conduit box is the Snap Action Handle designed to make separation an easy one-handed task.

Available in all ANSI thermocouple calibrations, the prongs and receptacle inserts are "standard" size and spacing. The jacks are high-impact nylon. The boxes are fabricated from die cast aluminum, and the mounting plate can be removed easily for internal wiring. **AVAILABLE FOR IMMEDIATE DELIVERY!**

Complete Assembly
$78
with the convenient Snap Action Handle

To Order

Specify Model **JPCB-5-☐-☐**

Thermocouple Calibration
Male (M), Female (F), or
Complete Assembly (MF

Example: **JPCB-5-K-MF**

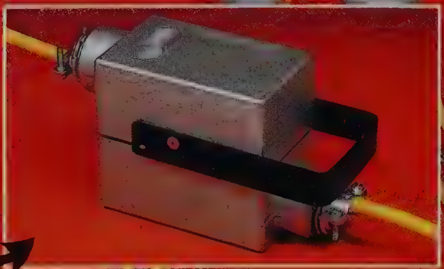
Male Conduit Box Assembly with Snap Action Handle	**$4**
Female Conduit Box Assembly	**$3**
Complete Price	**$7**

Includes 5-place plugs and jacks as shown in any combination.

When ordering an unusual combination of calibrations, consult Sales Department for exact sequence desired. ANSI calibrations J, K, T, R, S, E, or U (U is uncompensated)—in any combination, **$78**

Tungsten vs. Tungsten/Rhenium Thermocouple Alloys also available! Consult Sales Department when purchasing.

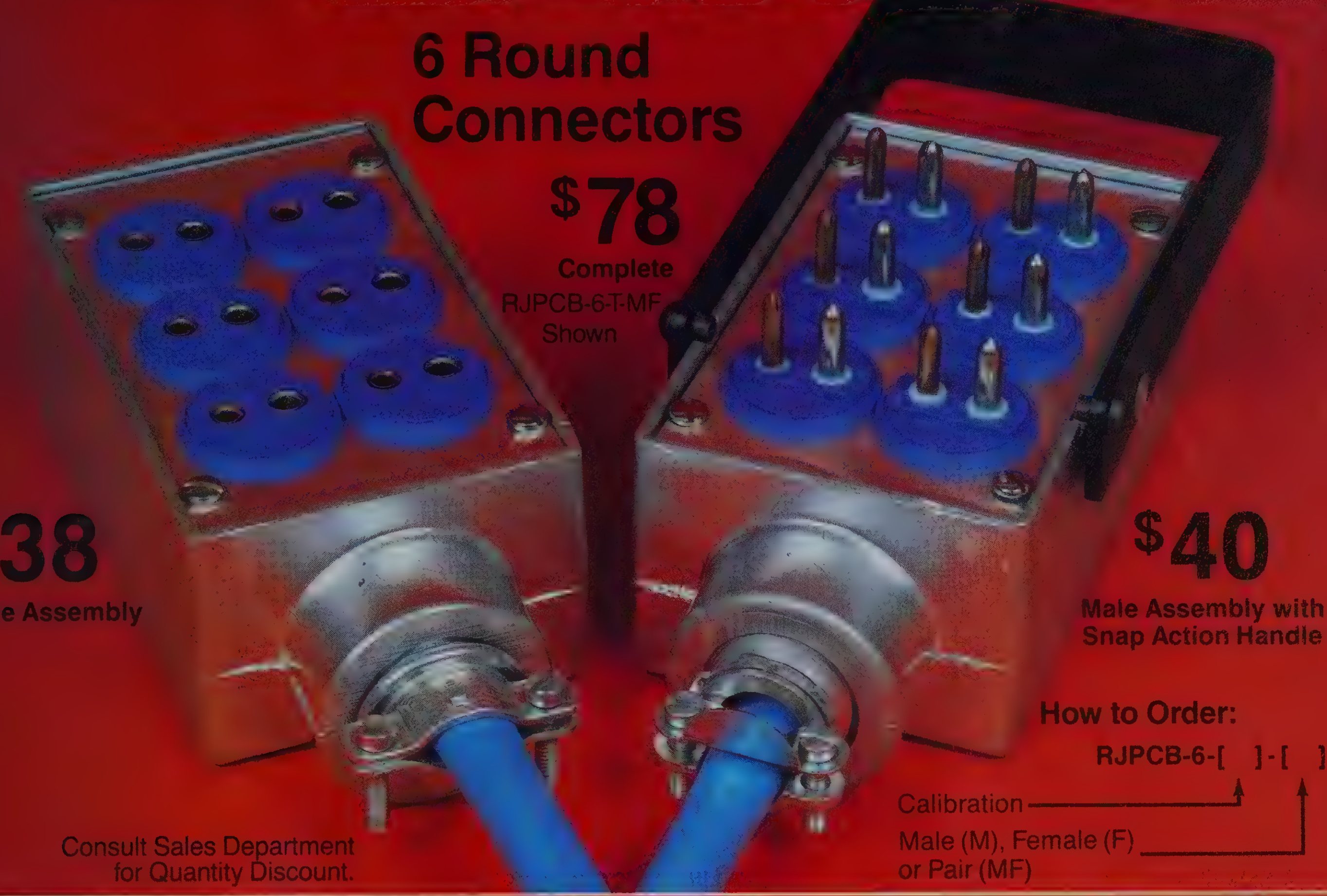
Complete Quick Disconnect Jack-Panel Conduit Box Assembly with Snap Action Handle



NEW! Jack Panel Conduit Box

6 Round Connectors

$78
Complete
RJPCB-6-T-MF
Shown



$38
Female Assembly

$40
Male Assembly with Snap Action Handle

How to Order:
RJPCB-6-[ ]-[ ]
Calibration
Male (M), Female (F) or Pair (MF)

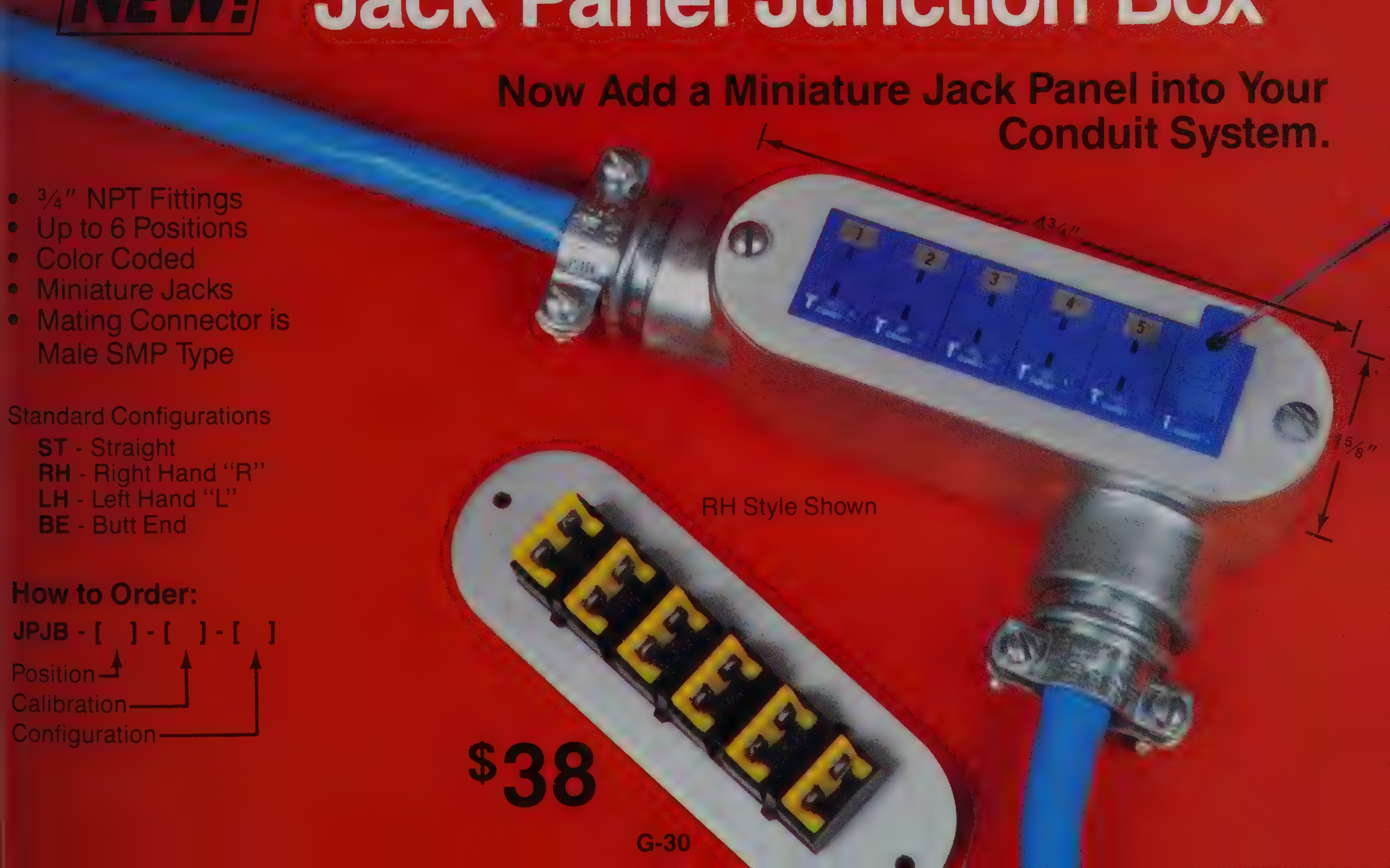
Consult Sales Department for Quantity Discount.

NEW! Jack Panel Junction Box

Now Add a Miniature Jack Panel into Your Conduit System.

- ¾″ NPT Fittings
- Up to 6 Positions
- Color Coded
- Miniature Jacks
- Mating Connector is Male SMP Type

Standard Configurations
ST - Straight
RH - Right Hand "R"
LH - Left Hand "L"
BE - Butt End



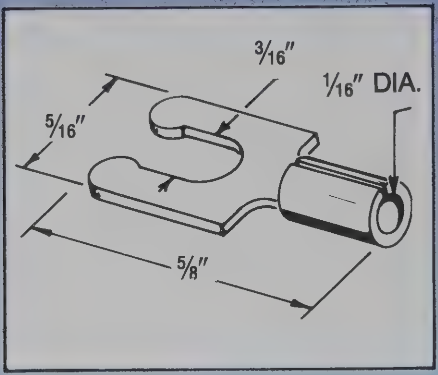
RH Style Shown

How to Order:
JPJB - [ ] - [ ] - [ ]
Position
Calibration
Configuration

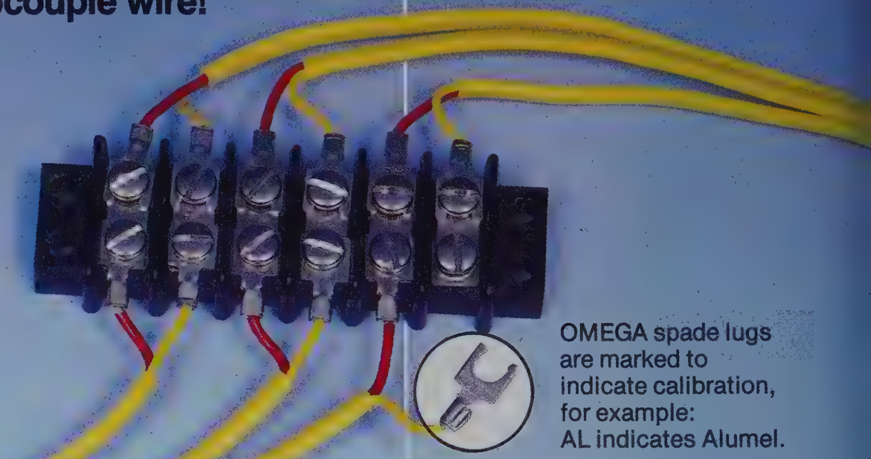
$38

Thermocouple Spade Lugs

Fast, easy connections to thermocouple wire!



Thermocouple spade lugs can be used with wire sizes from AWG 18 to as small as AWG 24, screw size up to number 8.



OMEGA spade lugs are marked to indicate calibration, for example:
AL indicates Alumel.

Thermocouple Spade Lugs are made from thermocouple compensating materials to be used with base and noble metal thermocouples.

Spade Lug Alloy	Catalog Designation
Chromel	SLCH-20
Alumel	SLAL-20
Iron	SLIR-20
Constantan	SLCO-20
Copper	SLCP-20
Alloy #11	SL11-20

$13/Package of 20

Keep extra lugs on hand.
26 packages and over $12/each.
Consult Sales Department for bul
pack pricing. Discount applies to
total order.

Crimping tool also available **$99**

Ratchet Action Easy-to-Use

To attach the thermocouple spade lugs to your thermocouple wire, OMEGA offers a crimping tool priced at $99. This tool operates on a ratchet principle to assure a complete crimp every time.

Thermocouple Alloy Terminal Lugs

For Terminal Blocks

Now! Convert Barrier-Type Terminals into Thermocouple Compensated Terminal Positions with OMEGA's Thermocouple Terminal Lugs.

Compensating Alloy Terminal Lugs are available for: CHROMEL • ALUMEL • IRON • COPPER • CONSTANTAN • PLATINUM-RHODIUM and TUNGSTEN-RHENIUM alloys.

To use, simply remove screws from terminals and drop terminal lugs in place. Replace screws and the terminal block is now a thermocouple strip. OMEGA's terminal lugs are marked to easily indicate calibration.

OMEGA Thermocouple Alloy Terminal Lugs are supplied in packages of 20. Quantity discount applies to total order. Twenty lugs is the minimum purchase per calibration.

Immediate Delivery on all items!

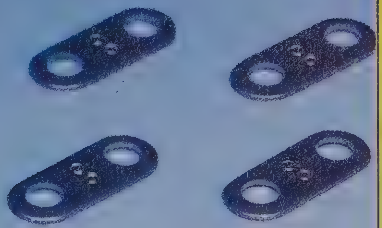
Terminal Lug Alloy	Catalog Designation
Chromel	TLCH-20
Alumel	TLAL-20
Iron	TLIR-20
Constantan	TLCO-20
Copper	TLCP-20
Alloy #11	TL11-20
Alloy #405	TL405-20
Alloy #426	TL426-20
Alloy #203	TL203-20
Alloy #225	TL225-20
Alloy #200	TL200-20
Alloy #226	TL226-20

Consult the Sales Department for bulk pack pricing.

$10/Package of 20

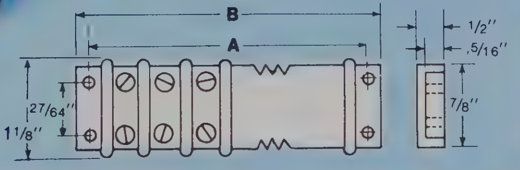
26 packages and over	**$9/ea.**

Discount applies to total order.



Compensating Alloys

Copper compensates either the Platinum 10% Rhodium or the Platinum 13% Rhodium leg.
Alloy **#11** compensates the Platinum leg when used with Copper.
Alloy **#405** compensates Tungsten 5% Rhenium - use only with Alloy **#426.**
Alloy **#426** compensates Tungsten 26% Rhenium - use only with Alloy **#405.**
Alloy **#203** compensates Tungsten 3% Rhenium - use only with Alloy **#225.**
Alloy **#225** compensates Tungsten 25% Rhenium - use only with Alloy **#203.**
Alloy **#200** compensates Tungsten - use only with Alloy **#226.**
Alloy **#226** compensates Tungsten 26% Rhenium - use only with Alloy **#200.**



TERMINAL BLOCKS ARE AVAILABLE FROM STOCK. ORDER LUGS SEPARATELY.

Number of Terminals	Dimension A	Dimension B	Strip Price Each	Catalog No.
2	1 5/16	1 5/8	**$2**	BS2
3	1 3/4	2 1/16	**2**	BS3
4	2 3/16	2 1/2	**2**	BS4
5	2 5/8	2 15/16	**3**	BS5
6	3 1/16	3 3/8	**3**	BS6
8	3 15/16	4 1/4	**4**	BS8
10	4 13/16	5 1/8	**5**	BS10
12	5 11/16	6	**6**	BS12
16	7 7/16	7 3/4	**8**	BS16
20	9 3/16	9 1/2	**9**	BS20

For your convenience, OMEGA offers the above listed barrier strips without terminal lugs. These strips are made of general purpose Bakelite.

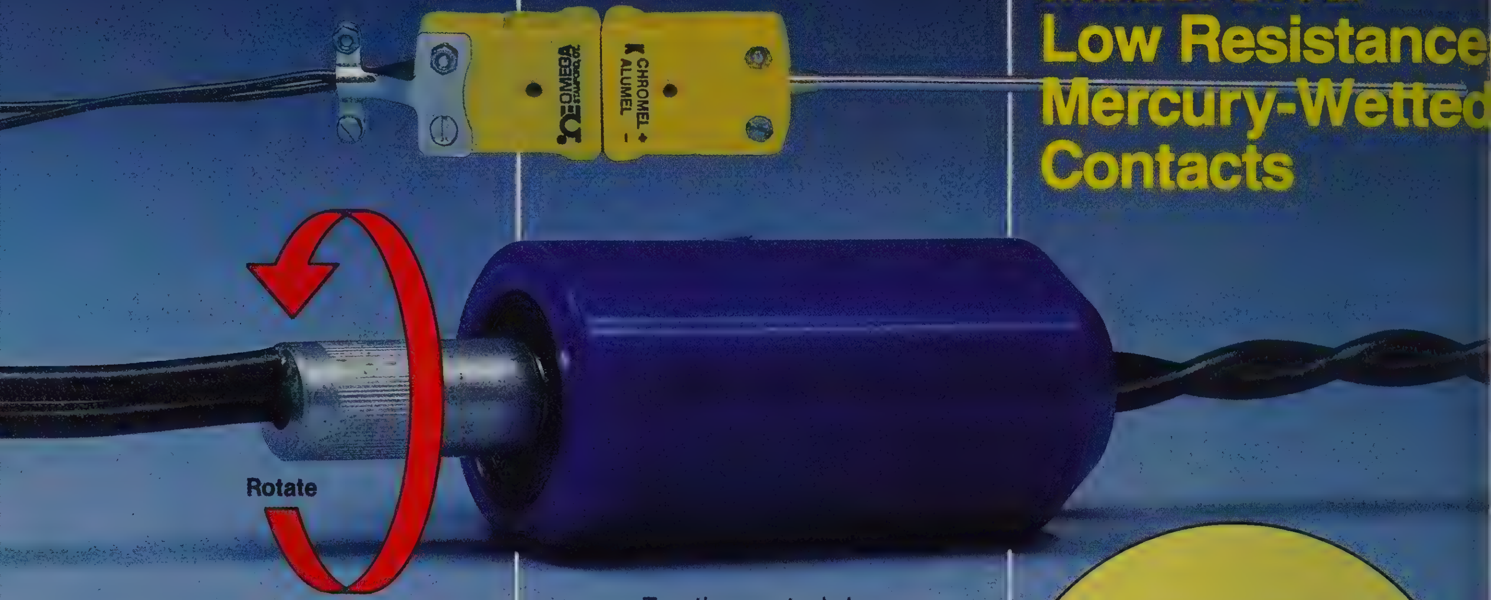
OMEGA's Thermocouple Alloy Terminal Lugs can be used with standard barrier strips or terminal blocks supplied by:

Cinch Jones - Series 141; Kulka - Series 601; Marathon - Series 200; Beauchaine - Series 18000

Listed above are some of the series part numbers of equivalent strips. While OMEGA's thermocouple alloy terminal lugs are completely interchangeable with these strips, check barrier strip catalog dimensions before ordering. Barrier strips are supplied in many different materials and numbers of terminals besides those listed by OMEGA.

Thermocouple Slip-Ring Assembly

Low Noise
Model SR-2
Low Resistance
Mercury-Wetted
Contacts


OMEGA
CHROMEL +
ALUMEL −
Rotate

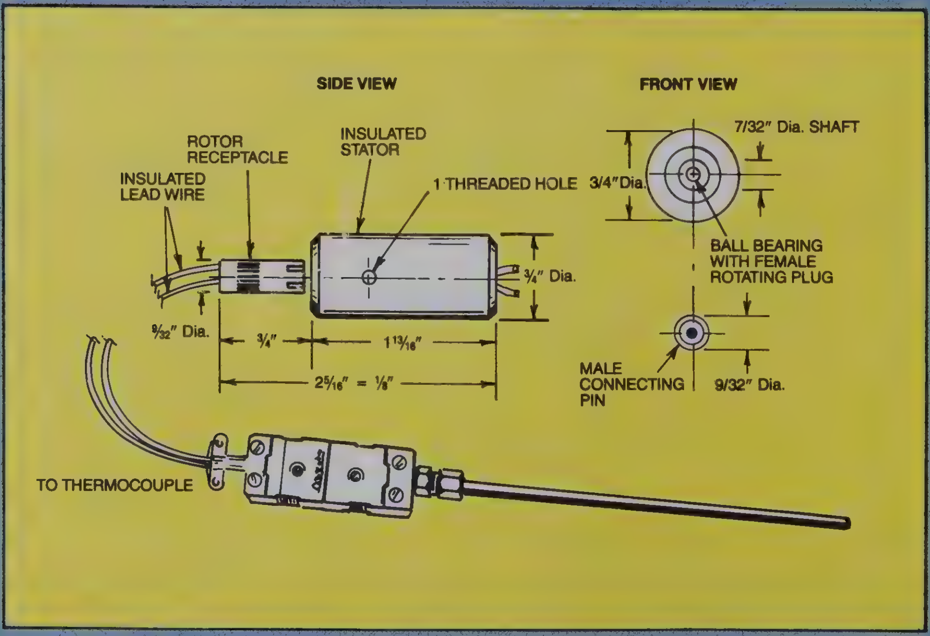
Two times actual size

Slip-ring Assembly Shown Actual Size

This low noise thermocouple slip-ring assembly is ideal for transmission of low level emf's where it is necessary to attach thermocouples to rotating parts.

It can be used with any thermocouple calibration. Its low noise design introduces a total signal error of less than five microvolts at rotational speeds up to 2000 rpm.

The output leads consist of plain copper wires; no compensation is included. The slip-ring assembly will transfer the true microvolt signal coming from a rotating assembly.


SIDE VIEW
FRONT VIEW
ROTOR RECEPTACLE
INSULATED STATOR
INSULATED LEAD WIRE
1 THREADED HOLE
3/4" Dia.
9/32" Dia.
3/4"
1 13/16"
2 5/16" ± 1/8"
7/32" Dia. SHAFT
3/4"Dia.
BALL BEARING WITH FEMALE ROTATING PLUG
MALE CONNECTING PIN
9/32" Dia.
TO THERMOCOUPLE

Specifications:

Mechanical Specifications

- Sealed Ball Bearings
- Speed: 0-2000 rpm (either direction)
- Operates in Any Position. When used vertically, the small shaft should be kept above the horizontal.

Electrical Specifications

- Voltage: 120 V Maximum
- Current: 1.0 Amp Maximum
- Frequency: dc to 10 MHz
- Temperature: −15° to 158°F (−26° to 70°C)

Model SR-2

$125

OFF-THE-SHELF DELIVERY

OMEGACOAT™

Color Epoxy-Coating for Thermocouple and RTD Heads

- **Available in 4 ANSI standard color codes, plus white.**
- **Resists chemical attack.**
- **Withstands temperatures up to 375°F continuously.**
- **Thick (average 3 mil) protection for all exposed surface areas.**
- **Pin-hole free, chip resistant factory electrostatic powder coating.**
- **Nonflammable, non-toxic.**

Now your thermocouple and RTD heads can be factory electrostatic coated with OMEGACOAT™ Epoxy Color Coating. OMEGACOAT™ gives chemical resistance to many acids, alkalies, salts, aliphatic and aromatic hydrocarbons, petroleum solvents, greases, detergents, and oils.

Price $7 Each (plus price of head)

See pages G-35 and G-36 for complete specifications and prices on heads. NOTE: OMEGACOATED heads are not supplied with chains. Colors may change when used continuously above 350°F. Not recommended for temperatures exceeding 375°F continuously.

"OFF-THE-SHELF"

Any of the following heads available with OMEGACOAT™ immediately.

Catalog No.	Material
NBI	Cast Iron
NB2*	Burnished Die Cast Aluminum
NBS*	Cast Aluminum
NSA*	Cast Iron

OMEGACOAT™ COLORS

ANSI Calibration Code	Calibration	Color
K	Chromel-Alumel	Yellow
J	Iron-Constantan	Black
T	Copper-Constantan	Blue
E	Chromel-Constantan	Purple
RTD	Uncompensated	White**

*Heads *are* supplied with chains, however the chains are not coated

**Not ANSI standard

Easy ordering instructions.
To construct catalog number:

Catalog Number	Price
NB1-☐-OC-☐	Thermocouple head price pages G-35 and G-36 plus $7
NB2-☐-OC-☐	
NBS-☐-OC-☐	
NSA-☐-OC-☐	

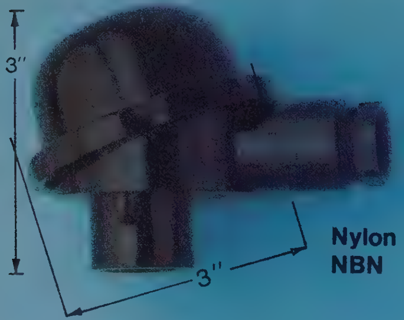
→ ANSI Calibration Code (K, J, T, E or RTD)
→ OC = OMEGACOAT™
→ 0 = No Terminal
2 = Single Element
4 = Dual Element
→ Thermocouple Head Type

EXAMPLE:
Catalog No. NBS-2-OC-K designates OMEGA's NBS Die Cast Aluminum head with 2-terminal (single element) block, OMEGACOATED in yellow for use with Type K thermocouple.
Price: $29 + $7 = $36.

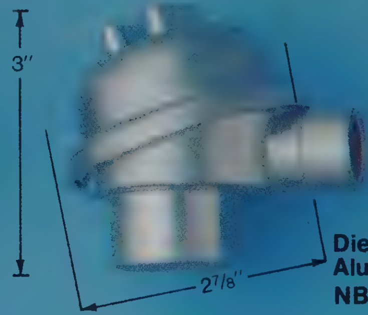
SPECIAL ORDERS:
For large quantity purchases, OMEGACOAT™ can be applied to other thermocouple and RTD heads in OMEGA's broad line. Special colors also available. Please consult factory.

Thermocouple Heads

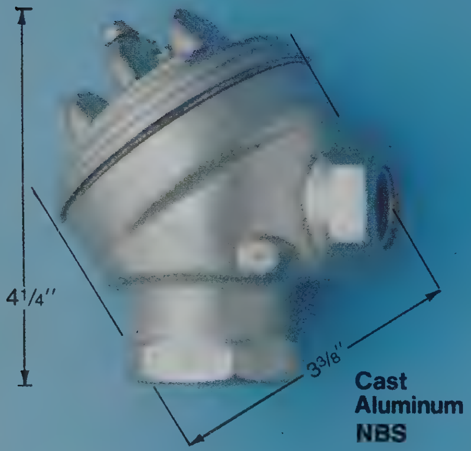
Connection Head



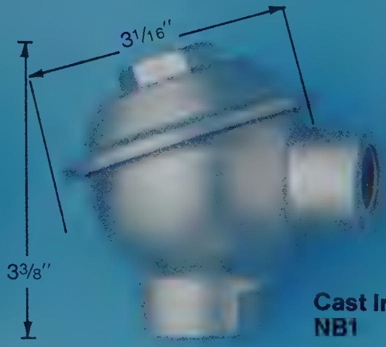
Nylon
NBN



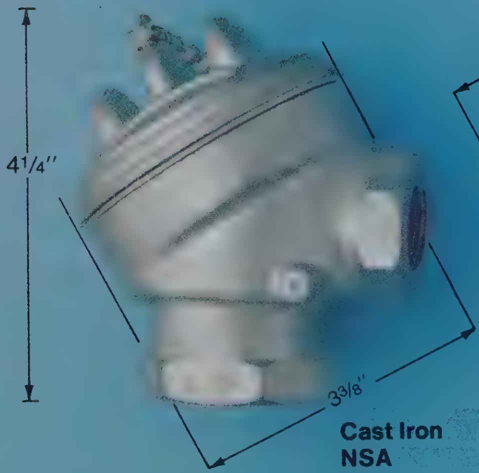
Die Cast
Aluminum
NBB



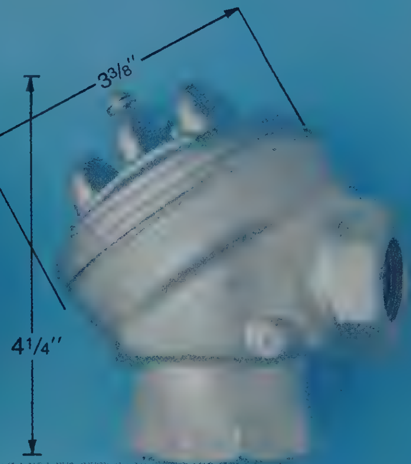
Cast
Aluminum
NBS



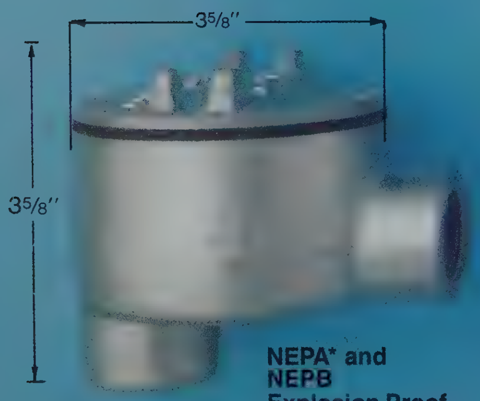
Cast Iron
NB1



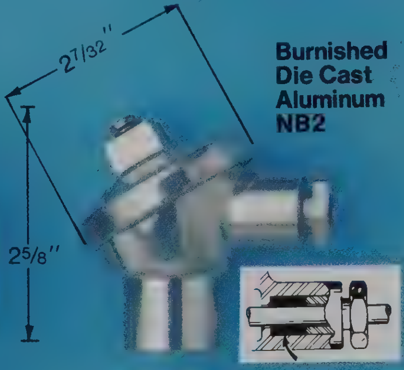
Cast Iron
NSA



Cast Iron
NSB



NEPA* and
NEPB
Explosion Proof



Burnished
Die Cast
Aluminum
NB2

Rubber Compression fitting or ½″ NPT thread when nut is removed

Material	Type	Cat. No.	Price Piec
Nylon	NBN	NBN-0 NBN-2 NBN-4	$19 22 24
Die Cast Aluminum	NBB	NBB-0 NBB-2 NBB-4	$2 2 2
Cast Aluminum	NBS	NBS-0 NBS-2 NBS-4	$2 2 3
Cast Iron	NB1	NB1-0 NB1-2 NB1-4	$2 2 2
Cast Iron	NSA	NSA-0 NSA-2 NSA-4	$2 2 2
	NSB	NSB-0 NSB-2 NSB-4	$2 2 2
	NSC	NSC-0 NSC-2 NSC-4	$2 2 2
Cast Aluminum Body and Cap	NEPA	NEPA-0 NEPA-2 NEPA-4	$3 4 4
	NEPB	NEPB-0 NEPB-2 NEPB-4	$4 4 4
Cast Iron with Aluminum Cap	NEP-T	NEP-TX NEP-TO NEP-T2 NEP-T4	$7 5 5 5
Burnished Die Cast Aluminum	NB2	NB2-0 NB2-2 NB2-4	$2 2 2

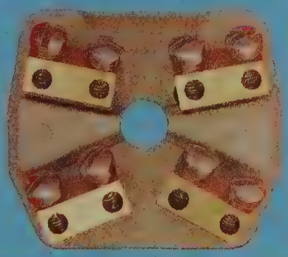
***NOTE:** The use of explosion proof heads does not imply that a complete assembly is either explosion proof or intrinsically safe. It is the user's responsibility to determine suitability of materials for an installation.

Terminal Blocks for Connection Heads

erminals	Weight ounces	Tapped Openings		Features
		Protection tube entry	Extension wire entry	
erminal block jle element lex element gage wire	3 4 5	½″ NPT	Supplied with nylon bushing for plastic covered extension wire to .240″-.400″ O.D.	● Easy accessibility to terminal block ● Suitable for use in ambient temperatures to 250°F ● Moisture and dust-resistant ● Ideal for chemical plant use ● Excellent corrosion resistance ● Very light weight
erminal block jle element lex element gage wire	6 7 8	½″ NPT	½″ NPT	● Good corrosion resistance ● Light weight ● Bayonet cover readily removed without tools ● Easy accessibility to terminal block ● Moisture and dust-resistant
erminal block jle element lex element jage wire	15 18 20	½″ NPT	½″ NPT	● Good corrosion resistance ● Light weight ● Cover, equipped with safety chain, readily removed without tools ● Moisture and dust-resistant
erminal block jle element lex element gage wire	22 23 24	½″ NPT	½″ NPT	● Rugged construction ● Screw cover with inside thread ● Moisture and dust-resistant ● Ideal for outdoor use
erminal block jle element lex element jage wire	42 46 48	½″ NPT	¾″ NPT	● Rugged construction ● Screw cover with inside thread ● Moisture and dust-resistant ● Ideal for outdoor use ● Standard OMEGA heavy-duty head (NSC is not shown, but in appearance is similar to the NSA and NSB heads.)
erminal block jle element lex element jage wire	40 44 46	¾″ NPT	¾″ NPT	
erminal block jle element lex element jage wire	36 40 42	1″ NPT	¾″ NPT	
erminal block jle element lex element gage wire	16½ 17¾ 18¼	¾″ NPT	¾″ NPT	● Explosion-Proof Head ● Rated for: Class I, Groups C, D Class II, Groups E, F, G Class III ● Screw cover with inside thread ● Moisture and dust-resistant ● Ideal for outdoor use
terminal block gle element lex element gage wire	21½ 22¾ 23¼	½″ NPT	½″ NPT	
is mounting plates for 2-wire transmitter erminal block gle element lex element gage wire	76 75 76¼ 76¾	½″ NPT	½″ NPT	● Explosion-proof enclosure for OMEGA 2-wire transmitter ● Rated for: Class I, Group C, D Class II, Group E, F, G Class III ● Screw cover with inside thread ● Moisture and dust resistant
erminal block gle element lex element gage wire	5 6 6½	½″ NPT Standard ¼″ NPT available Add "¼ NPT" after Cat. #	½″ NPT internal thread w/compression fitting nut and rubber ferrule for ⅛″ to ¼″ O.D. wire or tube	● Small and lightweight ● Good corrosion resistance ● Gasketed, weather resistant ● Burnished finish ● Safety chain on cover

CERAMIC BLOCK WITH NICKEL PLATED BRASS TERMINALS FOR NB2 HEAD. FOR 12 GAGE WIRE MAXIMUM

CAT. NO. If Ordered Separately	TERMINALS	WEIGHT	PRICE
CH49	2 = single	1½ oz.	$4
CH50	4 = duplex	2 oz.	6



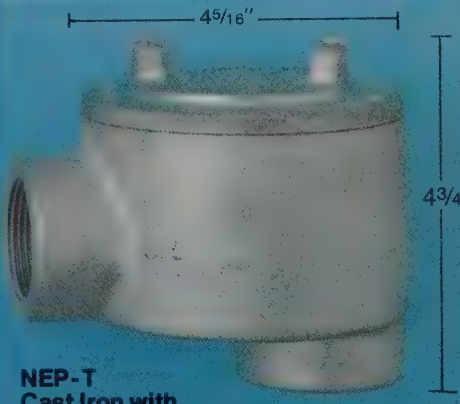
CERAMIC BLOCKS WITH BRASS TERMINALS FOR TYPE NSA, NSB, NSC & NBS CONNECTION HEADS FOR MAX. 8 GAGE WIRE

CAT NO. If Ordering Separately	TERMINALS	WEIGHT	PRICE
CH47	2 = single	3 ozs.	$6
CH48	4 = duplex	4½ ozs.	8

Improved Design

CERAMIC BLOCKS WITH BRASS TERMINALS FOR TYPE NBN, NBI & NBB CONNECTION HEADS FOR MAX. 14 GAGE WIRE

CAT. NO. If Ordering Separately	TERMINALS	WEIGHT	PRICE
CH73	2 = single	1¼ ozs.	$3
CH74	4 = duplex	1¾ ozs.	5



NEP-T
Cast Iron with Aluminum Cap Explosion Proof

For use with 2-Wire Transmitter.

Quantity Discount Schedule

1-99	List	500-749	10%
100-249	5%	750-999	12½%
250-499	7½%	1000-up	15%

Multiconductor Feedthroughs

- **Pressure or Vacuum Applications**
- **Seals Multiple Thermocouples**
- **Seals Multiple Protection Tubes**
- **¾″ NPT Mounting Thread**
- **Up to 12 Probes in 1 Fitting**

Optional Male Threaded Cap

Other styles shown on page G-39.

1/16″ SHEATHS

Number Openings	Catalog Number	Price Each
1	FT-116- 1	$ 65
2	FT-116- 2	72
3	FT-116- 3	79
4	FT-116- 4	87
5	FT-116- 5	95
6	FT-116- 6	103
7	FT-116- 7	111
8	FT-116- 8	119
9	FT-116- 9	127
10	FT-116-10	135
11	FT-116-11	143
12	FT-116-12	151

1/8″ SHEATHS

Number Openings	Catalog Number	Price Each
1	FT-18-1	$61
2	FT-18-2	67
3	FT-18-3	73
4	FT-18-4	79
5	FT-18-5	85
6	FT-18-6	91
7	FT-18-7	97

OPTIONAL MALE THREADED CAP

Catalog Number	Price Each
FTN-1	$25

3/16″ SHEATHS

Number Openings	Catalog Number	Price Each
1	FT-316-1	$63
2	FT-316-2	69
3	FT-316-3	75
4	FT-316-4	81
5	FT-316-5	87

1/4″ SHEATHS

Number Openings	Catalog Number	Price Each
1	FT-14-1	$63
2	FT-14-2	69
3	FT-14-3	75

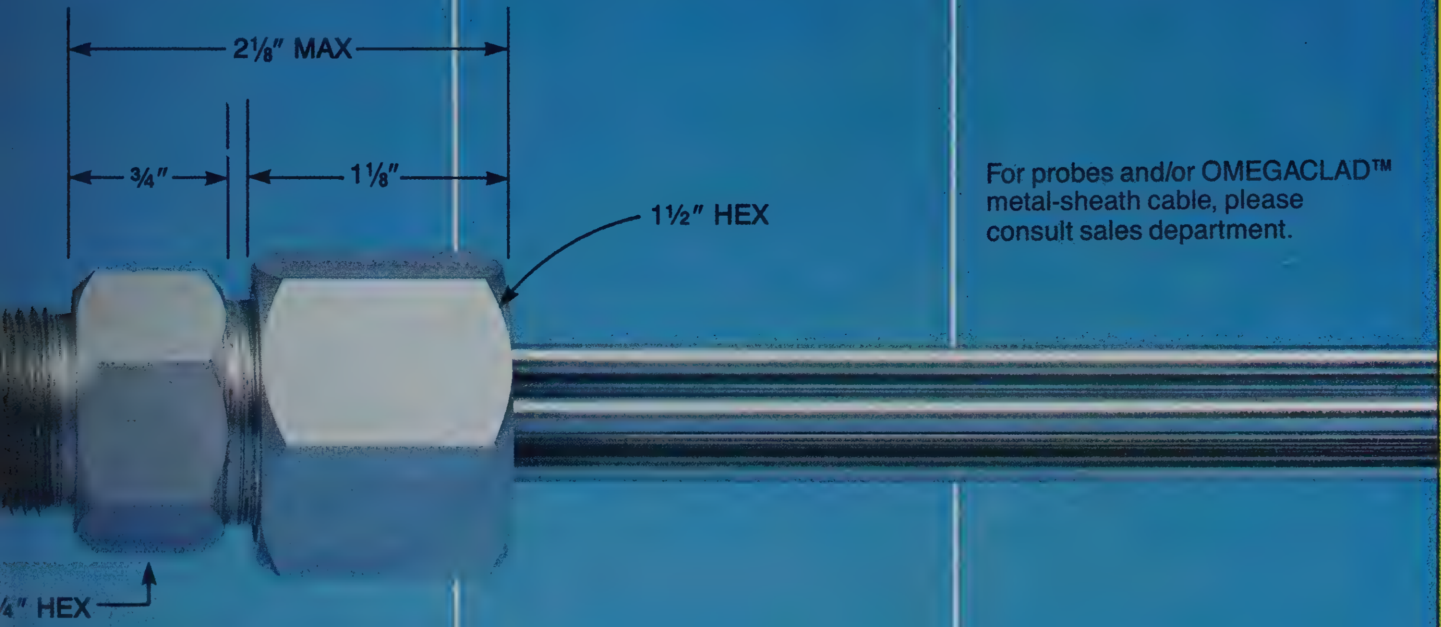
Multiconductor Feedthroughs

COMPRESSION-TYPE FOR VACUUM OR PRESSURE SEALING

hese all new multiconductor feedhroughs are designed for use in pplications that require several ensors to pass through a wall or ulkhead at one opening or within a mall area. Heavy-duty 416 stainless teel construction allows this fitting o be used in high pressure or acuum applications. Probes etween 1/16″ diameter and ¼″ iameter may be used in these eedthroughs. The maximum umber of probes per feedthrough s 3 for ¼″ diameter, 5 for 3/16″ iameter, 7 for ⅛″ diameter, and 12 or 1/16″ diameter probes.

All multiconductor feedthroughs are supplied in standard form with stainless steel ferrules. A stainless steel ferrule deforms and becomes permanent. If it is required that the probes be installed several times at different depths in the feedthrough, Teflon ferrules should be used. Teflon ferrules will not deform the probe sheath, allowing the same probe to be reused. The ferrules used in the feedthroughs are identical to the ferrules used in the standard OMEGALOK™ compression fittings.

- **3 to 12 Probes**
- **416SS Body and Cap**
- **316SS Ferrules Standard**
- **Teflon Ferrules Available**
- **Uses Standard OMEGALOK™ Ferrules**
- **1/16″ Through ¼″ Diameter Probes**



For probes and/or OMEGACLAD™ metal-sheath cable, please consult sales department.

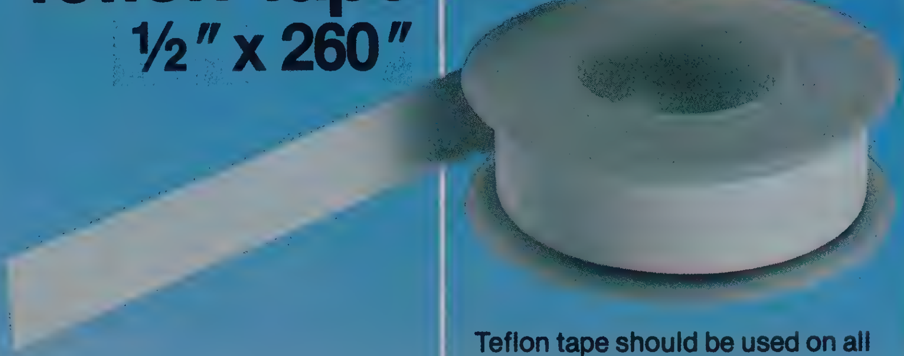
eplacement Ferrules

aterial	Dia.	Catalog Number	Price
Teflon	1/16	T-FER-1/16	$4
	⅛	T-FER-⅛	
	3/16	T-FER-3/16	
	¼	T-FER-¼	
316SS	1/16	SS-FER-1/16	$3
	⅛	SS-FER-⅛	
	3/16	SS-FER-3/16	
	¼	SS-FER-¼	

IOTE: All fittings are supplied tandard with stainless steel ferules. If Teflon ferrules are required, dd suffix-Teflon to the part umber shown. Add $1 to cost.

Teflon Tape

½″ x 260″



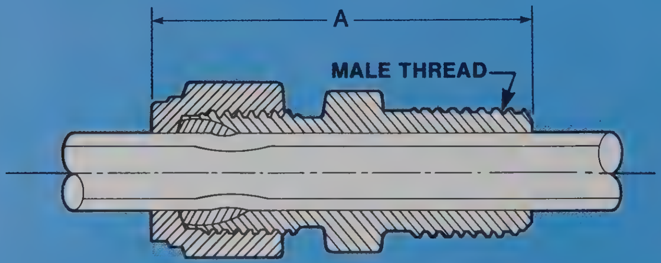
Teflon tape should be used on all pipe joints to provide a good seal and to prevent the threaded parts from seizing each other on disassembly.

$3.50/roll

OMEGALOK™ Compression Fittings

Prices start at $3.00

OMEGALOK™ Compression Fittings provide an efficient, convenient means of securing and sealing OMEGA thermocouples, RTDs and other probe-type sensors into tanks, chambers and pipes. The ferrule can be applied at any point along the probe's length. The metal ferrule is deformed when the seal is made which is accomplished by tightening up on the cap nut. Because of this, metal ferrules cannot be reused. Replacement ferrules are available — see below. Pressure ratings are up to 5,000 PSIG depending on material, assembly configuration and service temperature.



Protection Tube O.D.	Male Th'd NPT	"A" In.	Brass		316 Stainless Steel	
			Cat. No.	Pr. Ea.	Cat. No.	Pr. Ea.
1/16	1/16	.97	N/A	—	SSLK-116-116	$12.25
1/16	1/8	1.03	BRLK-116-18	$4.75	SSLK-116-18	12.00
1/8	1/8	1.18	BRLK-18-18	3.00	SSLK-18-18	8.00
1/8	1/4	1.74	BRLK-18-14	3.50	SSLK-18-14	8.50
3/16	1/8	1.22	BRLK-316-18	3.00	SSLK-316-18	8.00
3/16	1/4	1.81	BRLK-316-14	3.50	SSLK-316-14	8.50
1/4	1/8	1.29	BRLK-14-18	3.00	SSLK-14-18	8.00
1/4	1/4	1.48	BRLK-14-14	3.00	SSLK-14-14	7.00
5/16	1/4	1.54	N/A	—	SSLK-516-14	9.00
3/8	1/4	1.59	BRLK-38-14	3.50	SSLK-38-14	9.50
3/8	3/8	1.59	BRLK-38-38	4.00	SSLK-38-38	11.00
3/8	1/2	1.81	BRLK-38-12	5.25	SSLK-38-12	13.50
1/2	1/2	1.94	BRLK-12-12	6.00	SSLK-12-12	15.25

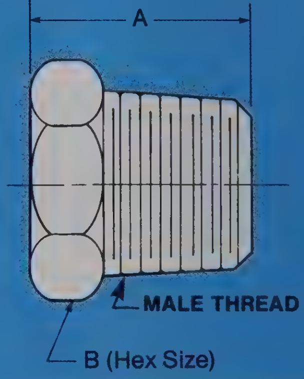
EXTRA & REPLACEMENT FERRULES ARE AVAILABLE.
TO ORDER, STATE PROTECTION TUBE O.D. & MATERIAL.
PR. EA. — BRASS $1.00, STAINLESS $3.00, TEFLON $4.00.

Pipe Thread Reducing Bushings

Prices start at $2.5

OMEGA Reducing Bushings are offered to assist users to adapt OMEGA thermocouple heads, assemblies and other apparatus to a variety of different pipe size openings in tanks, pipelines and chambers.

The fittings are available in both brass and 316 stainless steel. To order, fill in the box which follows the part number with either "BR" for Brass or "SS" for Stainless Steel.



NPT Thread		"B" Hex	"A" In.	Catalog Number	Price Each	
Male	Female				Brass	Stainless Steel
1/2	1/8	7/8	1.09	RB- 12-18-□	$3.25	$11.50
1/2	1/4	7/8	1.09	RB- 12-14-□	2.50	8.75
3/4	1/2	1 1/8	1.17	RB- 34-12-□	4.00	14.00
1	1/2	1 3/8	1.36	RB- 1-12-□	6.00	24.25
1	3/4	1 3/8	1.36	RB- 1-34-□	5.00	23.25
1 1/4	3/4	1 3/4	1.48	RB-114-34-CS	N/A	6.25*
1 1/4	1	1 3/4	1.48	RB-114- 1-CS	N/A	8.75*
1 1/2	1	2	1.56	RB-112- 1-CS	N/A	14.75*

FILL IN □ WITH "BR" = BRASS,
"SS" = STAINLESS STEEL

* THESE FITTINGS ARE AVAILABLE ONLY IN CARBON STEEL

PANELS PANELS PANELS

TYPE T THERMOCOUPLE THERMOMETER
MODEL 650
OMEGA
TYPE K THERMOCOUPLE THERMOMETER
MODEL 650
OMEGA

For every application

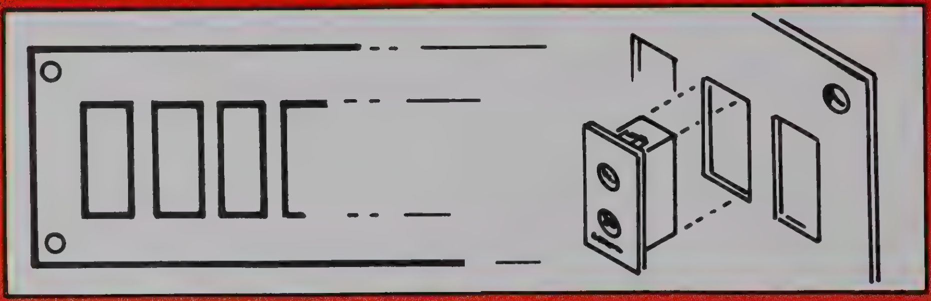
- Miniature
- Standard
- Three Prong
- Meters and Switches
- No Setup Charge for Standard Designs
- Custom Design—Send us your sketch for a free quote.

Jack Panels
With Color coded Standard Connectors

- Fully Assembled
- Snap-in Jacks
- Numbered Circuits
- Easy Installation
- Convenient
- Rugged 3/32″ Panels

OMEGA ENG. INC.
BOX 4047
STAMFORD, CT
1
2
3
4
5
6

Mounts in a Rectangular Cutout



OMEGA's standard size Jack Panels are fabricated using snap-in SPJ connectors in a 3⁄32″ aluminum panel.

The snap-in jacks contain two female, collet-type, spring loaded terminals that will accept any standard male thermocouple connector. They will accommodate wires up to 14 AWG and are made from alloys to match ANSI thermocouple grade calibrations.

The connector bodies are molded of high impact plastic and have a maximum service temperature of 400°F (205°C). The panels are machined from rugged 3⁄32″ (2.38 mm) aluminum with a brushed finish. Clear anodizing adds durability and corrosion resistance.

Because of the infinite variety of panel sizes and the different thermocouple calibrations we are not able to list all prices. Please consult the Sales Department for prices on any configuration not listed below.

Prices for OMEGA's standard Color coded Jack Panels are listed below. Specify Number of Rows, Total Number of Jacks and Calibration.

NOTE: Male plugs can be supplied in place of the female jacks on all OMEGA panels if desired.

PRICES FOR SINGLE, OFF-THE-SHELF, COLOR CODED JACK PANELS WITH STANDARD CONNECTORS

Circuits Per Row		1 Row (2⅝″ H)	2 Rows (4⅜″ H)	3 Rows (6⅝″ H)	4 Rows (8″ H)
6 (5¾″ L)	Cat. No. Price	SJP-1- 6-[*] **$45.50**	SJP-2-12-[*] **$70.84**	SJP-3-18-[*] **$98.76**	SJP-4-24-[*] **$126.68**
12 (10¼″ L)	Cat. No. Price	SJP-1-12-[*] **$65.84**	SJP-2-24-[*] **$116.68**	SJP-3-36-[*] **$159.96**	SJP-4-48-[*] **$208.28**
18 (14¾″ L)	Cat. No. Price	SJP-1-18-[*] **$88.76**	SJP-2-36-[*] **$154.96**	SJP-3-54-[*] **$213.60**	SJP-4-72-[*] **$279.80**

*Insert thermocouple calibration (see below)

PRICE AND QUANTITY DISCOUNT INFORMATION

The above prices are for J, K, T, E, R, S and U calibrations. To price panels with tungsten alloy connectors (calibrations G, C and D) or more than one panel of any type, use the following price schedule:

1 Row . . . . . $20 per panel, + jacks
2 Rows . . . . . $25 per panel, + jacks
3 Rows . . . . . $30 per panel, + jacks
4 Rows . . . . . $35 per panel, + jacks

Standard size panel jacks, Catalog No. SPJ Calibrations J, K, T, E, R, S and U: $4.25 ea. Tungsten alloy types G, C and D: $11.00 ea. Use connector quantity discount schedule at right. Blank panel prices are not discounted.

NOTE: All OMEGA SJP jack panels are assembled at no extra cost!

Connector Quantity Discounts

1 - 10	**Net**
11 - 24	**10%**
25 - 49	**15%**
50 - 99	**20%**
100 - 999	**25%**
1000 and over	**Consult Factory**

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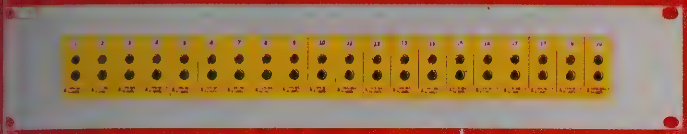
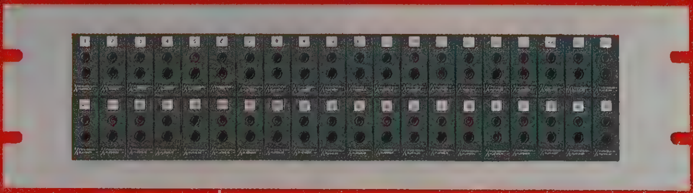
19″ Jack Panels
Standard Connectors

ugged 1/8″ (3.1 mm) Panels

9″ Plain Jack Panels





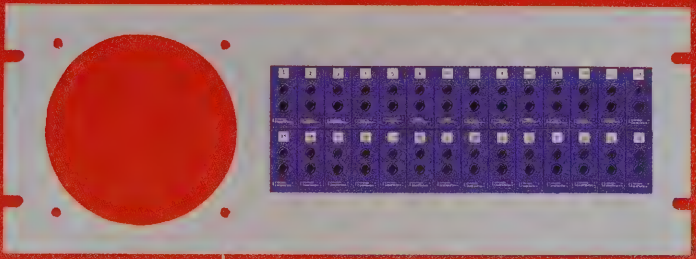
Rows	Panel Height	Price
1	3½″	$25 + jacks
2	5¼″	$30 + jacks
3	7 ″	$35 + jacks
4	8¾″	$40 + jacks

Stocked Configurations
1 Row 10, 20 positions
2 Rows 30, 40 positions

22 positions per row maximum.

NOTE: All OMEGA 19SJP jack panels are assembled at no extra cost.

9″ Jack Panels With Switch Cutouts



Rows	Panel Height	Switch Cutout	Price
1	5¼″	3″	$35 + jacks
2	5¼″	3″	$35 + jacks
3	7 ″	5″	$40 + jacks
4	8¾″	5″	$45 + jacks

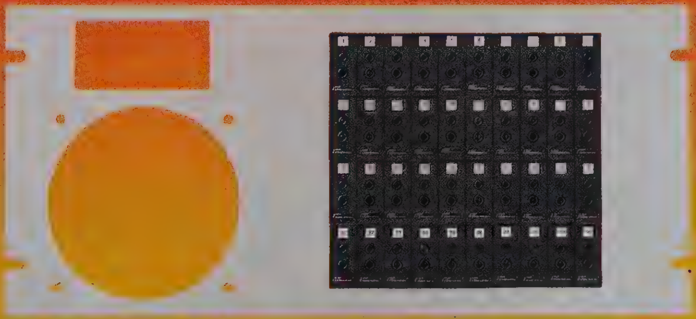
Stocked Configurations
1 Row 10 positions
2 Rows 20 positions
3 Rows 30 positions
4 Rows 40 positions

15 positions per row maximum.

NOTE: When a switch is ordered with a panel, OMEGA will install it at no extra charge.

Refer to page G-28 for the complete selection of available switches.

9″ Jack Panels With Switch ind Meter Cutouts



Rows	Panel Height	Switch Cutout	Price
1*	5¼″	3″	$40 + jacks
2*	5¼″	3″	$40 + jacks
3**	8¾″	5″	$45 + jacks
4**	8¾″	5″	$45 + jacks

Stocked Configurations
1 Row 10 positions
2 Rows 20 positions
3 Rows 30 positions
4 Rows 40 positions

*10 positions per row maximum
**15 positions per row maximum

NOTE: A 92 × 45 mm (3.622 × 1.772 in.) meter cutout will be supplied unless otherwise specified.
Factory wiring is available—**$5** per circuit.

---

ow to Order: **19SJP-[ ]-[ ]-[ ]-OSW-MTR**

Number of Rows
Total Number of Jacks
Calibration
Meter Cutout (optional)
Switch Cutout (optional)

Standard panel jacks, Catalog No. SPJ
Calibrations J, K, T, E, R, S, U: **$4.25**
Tungsten alloy types G, C and D: **$11.00**

Use connector quantity discount schedule on facing page.

Jack Panels

With Color Coded Miniature Connectors.

- Snap-in Assemblies
- Numbered Circuits
- Off-the-Shelf Sizes
- Accepts Miniature or Subminiature Male Plugs

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1
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3
4
5
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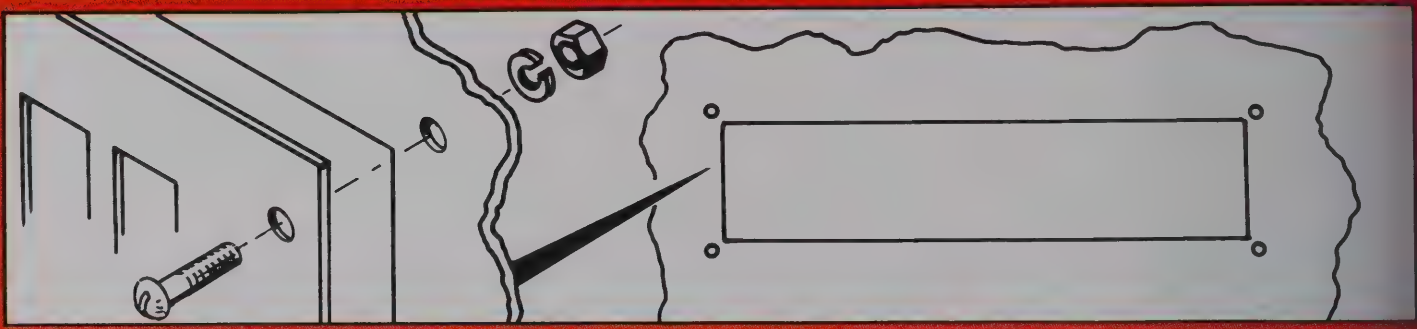
K CHROM + ALUMEL -
K CHROM + ALUMEL -
K CHROM + ALUMEL -
K CHROM + ALUMEL
CHROMEL + ALUMEL
OMEGA

Mounts in a Rectangular Cutout



OMEGA Miniature Jack Panels are fabricated using miniature panel jacks and snap strip assemblies in a clear anodized aluminum plate. Some prices for OMEGA's Panels with miniature color coded jacks are listed below. Because of the infinite variety of panel sizes and the different thermocouple calibrations, we are not able to list all prices. Special panels are available with switches, meter or both. Please consult the sales department for price on any configuration not listed below. Specify number of rows, total number of jacks and calibration. All prices include panel and jacks.

The connector bodies are molded of high impact plastic and have a maximum service temperature of 400°F (205°C). The panels are machined from rugged 3/32″ (2.38m aluminum with a brushed finish. Clear anodizing adds durability and corrosion resistance.

PRICES FOR SINGLE, OFF-THE-SHELF, COLOR CODED JACK PANELS WITH MINIATURE CONNECTORS

Circuits Per Row		1 Row (1¾″ H)	2 Rows (3¼″ H)	3 Rows (4¼″ H)	4 Rows (5¼″ H)
6 (4⅜″ L)	**Cat. No.** **Price**	MJP-1- 6-[*] **$33.50**	MJP-2-12-[*] **$44.30**	MJP-3-18-[*] **$61.45**	MJP-4-24-[*] **$73.60**
12 (8⅛″ L)	**Cat. No.** **Price**	MJP-1-12-[*] **$44.30**	MJP-2-24-[*] **$68.60**	MJP-3-36-[*] **$97.90**	MJP-4-48-[*] **$116.80**
18 (11⅞″ L)	**Cat. No.** **Price**	MJP-1-18-[*] **$56.45**	MJP-2-36-[*] **$88.85**	MJP-3-54-[*] **$122.20**	MJP-4-72-[*] **$154.60**

*Insert thermocouple calibration (see below)

PRICE AND QUANTITY DISCOUNT INFORMATION

The above prices are for J, K, T, E, R, S, G, C, D and U calibrations. To price more than one panel of any type, use the following price schedule:

1 Row . . . . . $20 per panel, + jacks
2 Rows . . . . . $20 per panel, + jacks
3 Rows . . . . . $25 per panel, + jacks
4 Rows . . . . . $25 per panel, + jacks

Miniature panel jacks, Catalog No. MPJ: $2.25 ea. Use connector quantity discount schedule at right. Blank panel prices are not discounted.

NOTE: All OMEGA MJP jack panels are assembled at no extra cost!

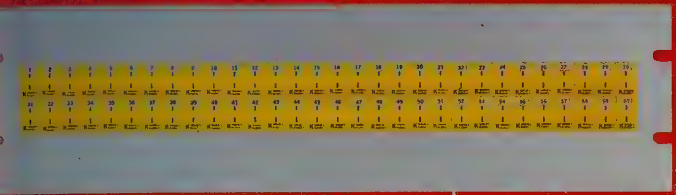
Connector Quantity Discounts

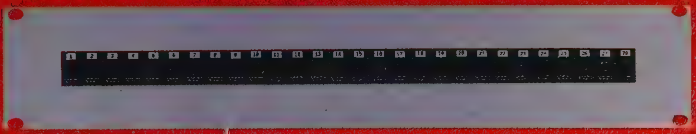
1 - 10	**Net**
11 - 24	**10%**
25 - 49	**15%**
50 - 99	**20%**
100 - 999	**25%**
1000 and over	**Consult Sales Department**

19″ Jack Panels
Miniature Connectors

ugged 1/8″ (3.1 mm) Panels

9″ Plain Jack Panels





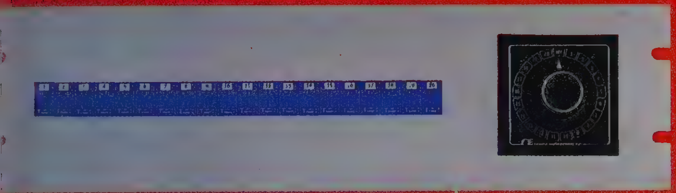
Rows	Panel Height	Price
1	3½″	$25 + jacks
2	5¼″	$30 + jacks
3	7 ″	$35 + jacks
4	8¾″	$40 + jacks

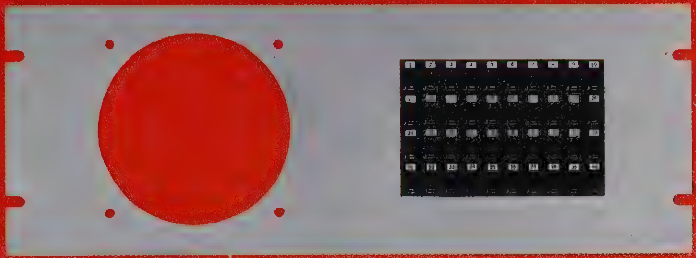
Stocked Configurations
1 Row 10, 20, 30 positions
2 Rows 32, 40 positions

30 positions per row maximum.

NOTE: All OMEGA 19MJP jack panels are assembled at no extra cost.

9″ Jack Panels With Switch Cutouts





Rows	Panel Height	Switch Cutout	Price
1	5¼″	3″	$35 + jacks
2	7 ″	3 or 5″	$40 + jacks
3	8¾″	5″	$45 + jacks
4	8¾″	5″	$45 + jacks

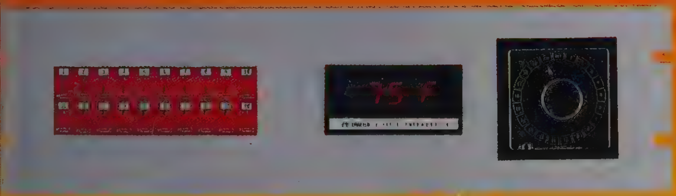
Stocked Configurations
1 Row 10, 20 positions
2 Rows 20, 40 positions
3 Rows 30, 40 positions
4 Rows 40 positions

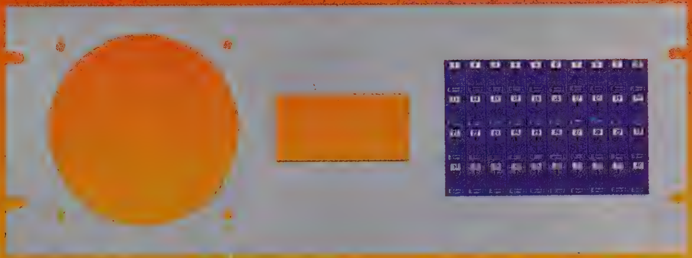
20 positions per row maximum.

NOTE: When a switch is ordered with a panel, OMEGA will install it at no extra charge.

Refer to page G-28 for the complete selection of available switches.

9″ Jack Panels With Switch nd Meter Cutouts





Rows	Panel Height	Switch Cutout	Price
1	5¼″	3″	$40 + jacks
2	5¼″	3″	$40 + jacks
3	8¾″	5″	$50 + jacks
4	8¾″	5″	$50 + jacks

Stocked Configurations
1 Row 10, 20 positions
2 Rows 20 positions
3 Rows 30 positions
4 Rows 40 positions

10 positions per row maximum.

NOTE: A 3.622 × 1.772 in. 92 × 45 mm meter cutout will be supplied unless otherwise specified.

Factory wiring is available—**$5** per circuit.

How to Order: **19MJP-[ ]-[ ]-[ ]-OSW-MTR**

Number of Rows
Total Number of Jacks
Calibration
Switch Cutout (optional)
Meter Cutout (optional)

Miniature size panel jacks, Catalog No. MPJ: **$2.25** ea.

Use connector quantity discount schedule on facing page.

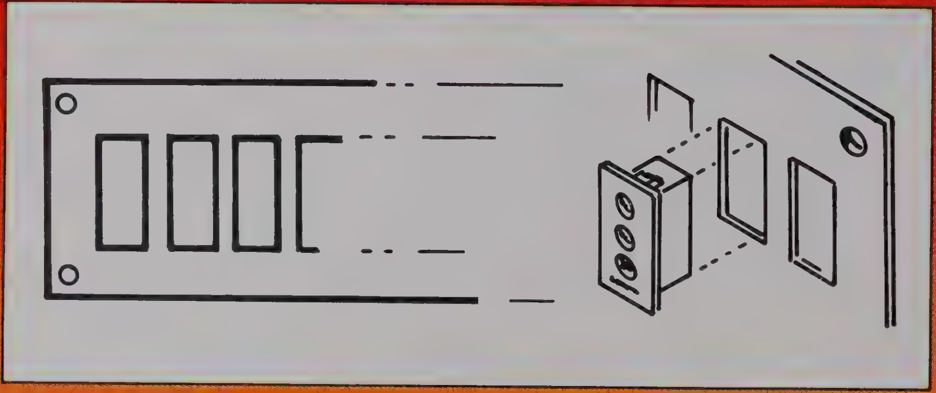
Jack Panels
With Color Coded 3 Prong Connectors
Type TJP

1
2
3
4
5
6
Cu/Cu COPPER + COPPER −

- Fully Assembled
- Snap-in Jacks
- Numbered Circuits
- For RTDs, Thermistors or Shielded Thermocouples

NOW! OMEGA introduces jack panels for use with RTDs, thermistor and shielded thermocouples! Using the TPJ snap-in panel jacks, the sam versatility given to thermocouples is now possible for sensors requiring 3 lead wires.

Mounts in a Rectangular Cutout



The snap-in jacks have 3 female terminals that will accept any 3 prong OTP male connector. They can accommodate wires up to 14 AWG and are made from alloys to match ANSI thermocouple grade calibrations.

The TPJ panel jacks are made of rugged, high impact plastic, and hav a maximum service temperature of 400°F (205°C). They are mounted ir 3/32″ panels of anodized aluminum.

NOTE: Male plugs can be supplied in place of the female jacks on all OMEGA panels, if desired.

PRICES FOR SINGLE, OFF-THE-SHELF, COLOR-CODED JACK PANELS WITH 3-PRONG CONNECTORS

Circuits Per Row		1 Row (2⅝″ H)	2 Rows (5¼″ H)	3 Rows (8″ H)	4 Rows (10″ H)
6 (5¾″ L)	Cat. No. Price	TJP-1- 6-[*] **$53.00**	TJP-2-12-[*] **$84.40**	TJP-3-18-[*] **$119.10**	TJP-4-24-[*] **$153.80**
12 (10¼″ L)	Cat. No. Price	TJP-1-12-[*] **$71.40**	TJP-2-24-[*] **$143.80**	TJP-3-36-[*] **$198.30**	TJP-4-48-[*] **$259.40**
18 (14¾″ L)	Cat. No. Price	TJP-1-18-[*] **$109.10**	TJP-2-36-[*] **$193.30**	TJP-3-54-[*] **$267.60**	TJP-4-72-[*] **$351.80**

*Insert thermocouple calibration (see below)

PRICE AND QUANTITY DISCOUNT INFORMATION

The above prices are for J, K, T, E, and U calibrations. To price more than one panel of any type, use the following price schedule:

1 Row ..... $20 per panel, + jacks
2 Rows ..... $25 per panel, + jacks
3 Rows ..... $30 per panel, + jacks
4 Rows ..... $35 per panel, + jacks

3 prong panel jacks, Catalog No. TPJ: $4.50 ea. Use connector quantity discount schedule at right. Blank panel prices are not discounted.

NOTE: All OMEGA TJP jack panels are assembled at no extra cost!

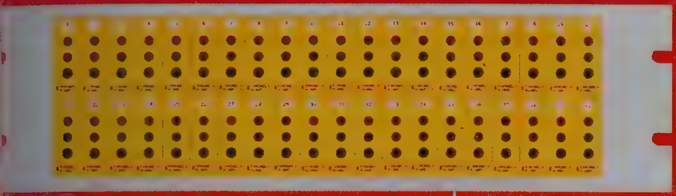
Connector Quantity Discounts

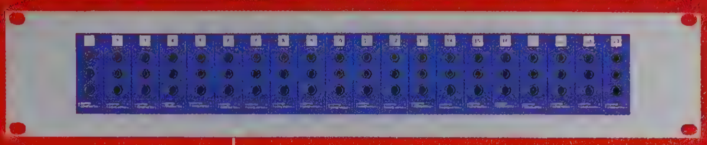
1 - 10	Net
11 - 24	10%
25 - 49	15%
50 - 99	20%
100 - 999	25%
1000 and over	Consult Factory

19″ Jack Panels
3 Prong Connectors

ugged 1/8″ (3.1 mm) Panels

9″ Plain Jack Panels





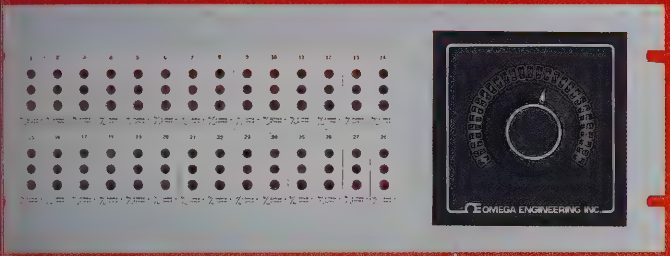
Rows	Panel Height	Price
1	3½″	$25 + jacks
2	7 ″	$35 + jacks
3	8¾″	$40 + jacks
4	10½″	$45 + jacks

Stocked Configurations
1 Row 10, 20 positions
2 Rows 30, 40 positions

22 positions per row maximum.

NOTE: All OMEGA 19TJP jack panels are assembled at no extra cost.

9″ Jack Panels With Switch Cutouts



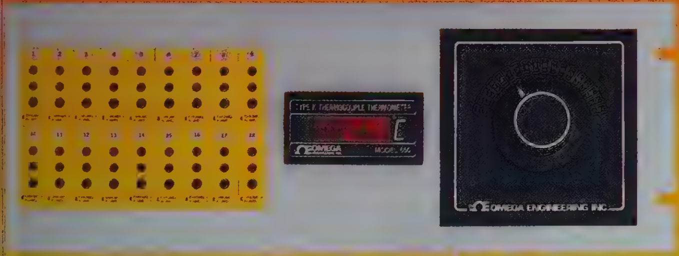
ows	Panel Height	Switch Cutout	Price
1	5¼″	5″	$35 + jacks
2	7 ″	5″	$40 + jacks
3	8¾″	5″	$45 + jacks
4	10½″	5″	$50 + jacks

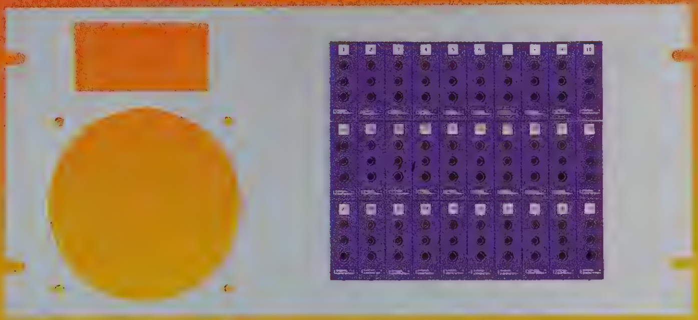
Stocked Configurations
1 Row 10 positions
2 Rows 20 positions
3 Rows 30 positions
4 Rows 40 positions

15 positions per row maximum.

NOTE: When a switch is ordered with a panel, OMEGA will install it at no extra charge.
Refer to page G-28 for the complete selection of available switches.

9″ Jack Panels With Switch nd Meter Cutouts





ows	Panel Height	Switch Cutout	Price
1*	7 ″	5″	$45 + jacks
2*	7 ″	5″	$45 + jacks
3**	8¾″	5″	$50 + jacks
4**	10½″	5″	$55 + jacks

Stocked Configurations
1 Row 10 positions
2 Rows 20 positions
3 Rows 30 positions
4 Rows 40 positions

*10 positions per row maximum.
**15 positions per row maximum.

NOTE: A 92 × 45 mm (3.622 × 1.772 in.) meter cutout will be supplied unless otherwise specified.
Factory wiring is available—**$5** per circuit.

---

ow to Order: 19TJP-[ ]-[ ]-[ ]-OSW-MTR

Number of Rows
Total Number of Jacks
Calibration
Switch Cutout (optional)
Meter Cutout (optional)

3 Prong panel jacks, Catalog No. TPJ
Calibrations J,K,T,E and U: **$4.50** ea.

Use connector quantity discount schedule on facing page.

Jack Panels
High Temperature

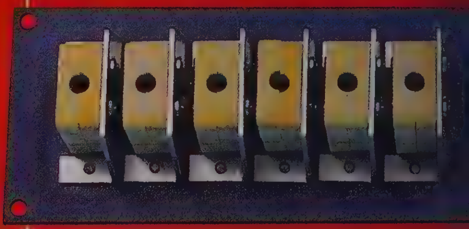
- **Ceramic Connectors**
- **Steel Panel**
- **Compensated Hardware**

OMEGA high temperature jack panels feature ceramic connecto mounted in a steel plate for servic temperatures up to 1000°F (537°C

Upper Temperature Li is determined by Alloy Ty

See page G-9 for Connector Descripti

NOTE: Male connectors can be supplied in place of the female jacks. Consult Sales Department.



Exclusive Split Shell Design Simplifies Wiri

PRICES FOR SINGLE, OFF-THE-SHELF, COLOR CODED JACK PANELS

Circuits Per Row		1 Row (2¾" H)	2 Rows (4¼" H)	3 Rows (6¼" H)	4 Rows (7¾" H)
6 (5¾" L)	Cat. No. Price	NXJP-1- 6-[*] **$79.00**	NXJP-2-12-[*] **$127.20**	NXJP-3-18-[*] **$180.80**	NXJP-4-24-[*] **$234.40**
12 (10¼" L)	Cat. No. Price	NXJP-1-12-[*] **$122.20**	NXJP-2-24-[*] **$224.40**	NXJP-3-36-[*] **$310.40**	NXJP-4-48-[*] **$428.80**
18 (14¾" L)	Cat. No. Price	NXJP-1-18-[*] **$170.80**	NXJP-2-36-[*] **$305.40**	NXJP-3-54-[*] **$423.80**	NXJP-4-72-[*] **$558.40**

*Insert thermocouple calibration (see below)

PRICE AND QUANTITY DISCOUNT INFORMATION

The above prices are for J, K, T, E, R, S, G, C, D and U calibrations. To price more than one panel of any type, use the following price schedule:

1 Row	$25 per panel,	+ connectors
2 Rows	$30 per panel,	+ connectors
3 Rows	$35 per panel,	+ connectors
4 Rows	$40 per panel,	+ connectors

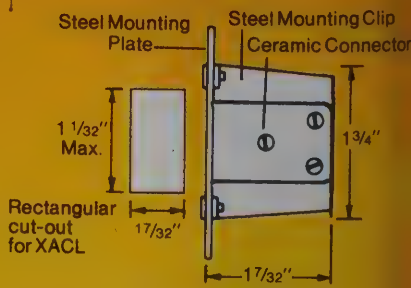
Ceramic connectors, catalog no. NOX Calibrations J, K, T, E, R, S, G, C, D and U: $9.00 ea. (includes panel mounting clip, catalog no. XACL.) (Clips available separately for $3.00 ea.) Use quantity discount schedule at right. Blank panel prices are not discounted.

NOTE: All OMEGA NXJP jack panels are shipped unassembled, with all necessary hardware for mounting included.

Connector Quantity Discounts

1 - 10	**Net**
11 - 24	**10%**
25 - 49	**15%**
50 - 99	**20%**
100 - 999	**25%**
1000 and over	**Consult Factory**

Panel Mounting Adaptor Clip



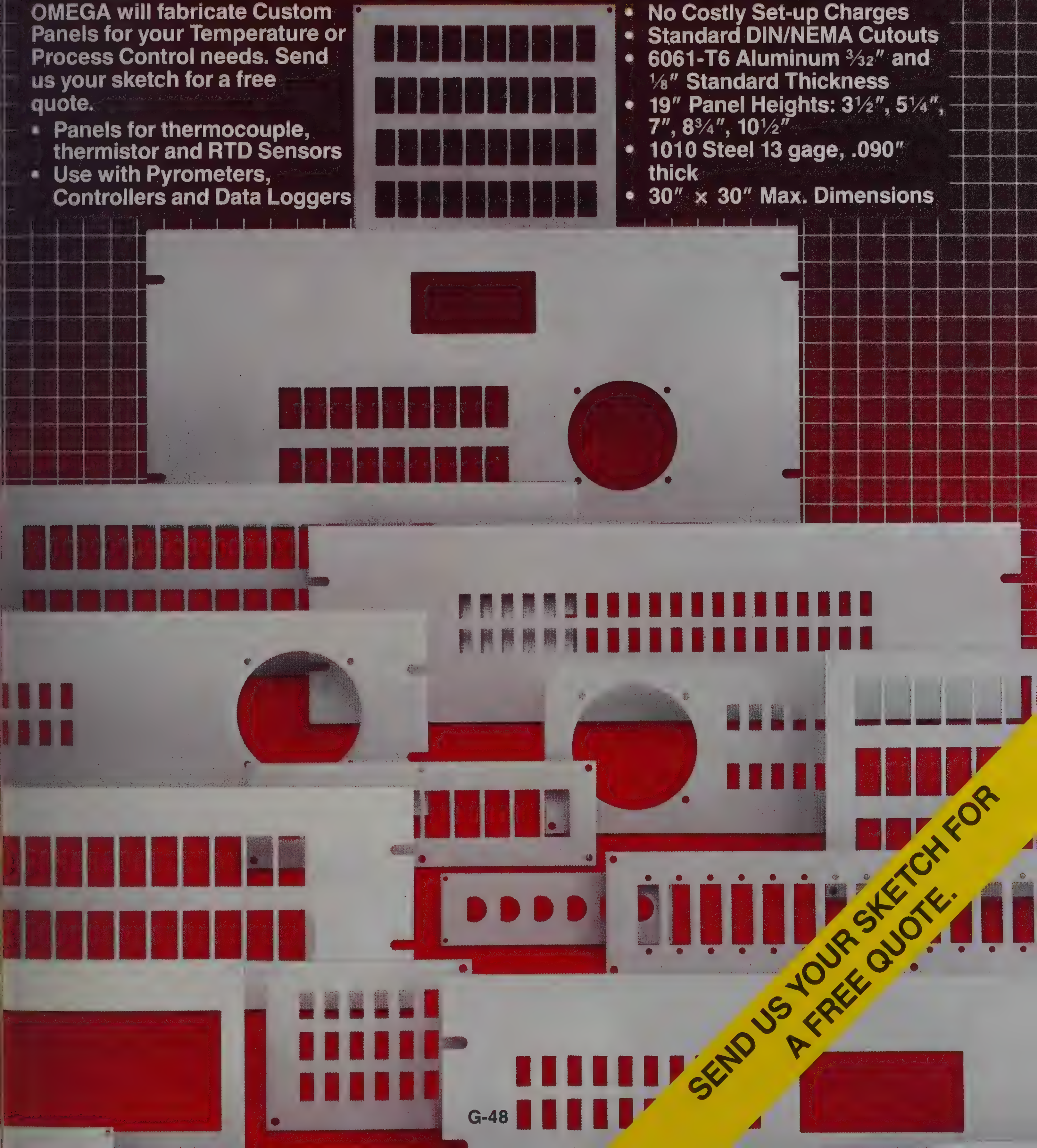
Catalog No. XACL $3

CUSTOM INSTRUMENTATION AND CONTROL PANELS

OMEGA will fabricate Custom Panels for your Temperature or Process Control needs. Send us your sketch for a free quote.

- Panels for thermocouple, thermistor and RTD Sensors
- Use with Pyrometers, Controllers and Data Loggers

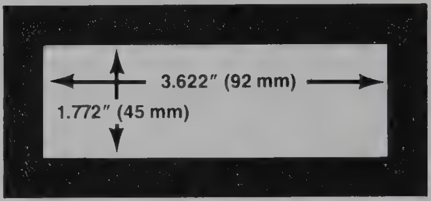
- No Costly Set-up Charges
- Standard DIN/NEMA Cutouts
- 6061-T6 Aluminum 3/32″ and 1/8″ Standard Thickness
- 19″ Panel Heights: 3½″, 5¼″, 7″, 8¾″, 10½″
- 1010 Steel 13 gage, .090″ thick
- 30″ × 30″ Max. Dimensions



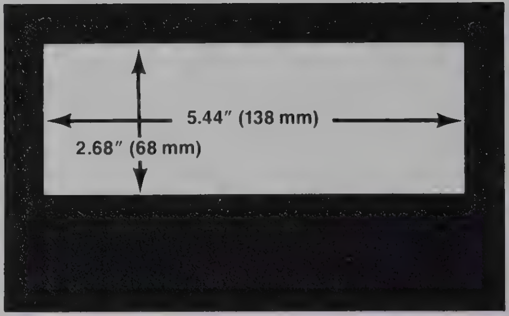
STANDARD CUTOUT

DIGITAL THERMOMETERS

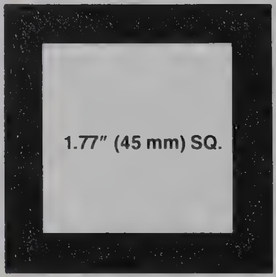
SERIES
199, 650, 660,
2160, 2170

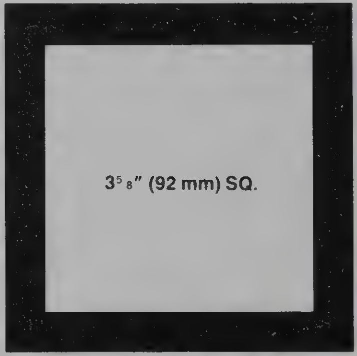

3.622″ (92 mm)
1.772″ (45 mm)

SERIES
400


5.44″ (138 mm)
2.68″ (68 mm)

TEMPERATURE CONTROLLERS

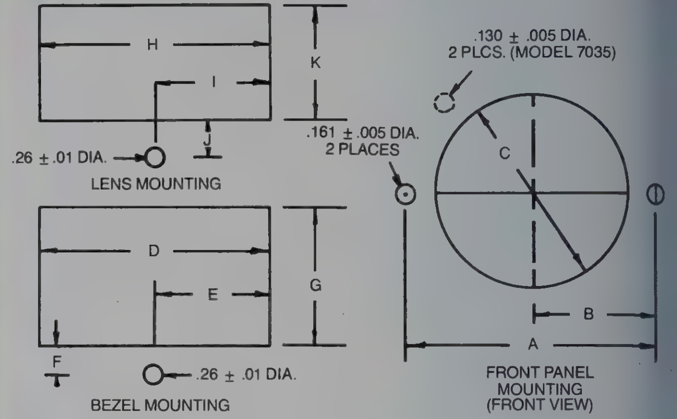




SERIES
6100

SERIES
20, 49, 50, 1400, 1500,
1600, 4000,
149, 150, 920, 4200, 6000

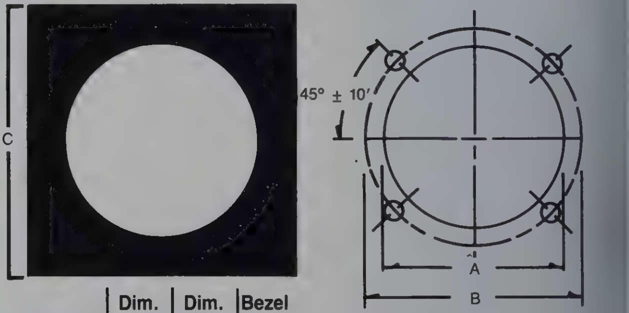
ANALOG PYROMETERS SERIES 7


H
I
K
J
.26 ± .01 DIA.
LENS MOUNTING
D
E
G
F
.26 ± .01 DIA.
BEZEL MOUNTING
.130 ± .005 DIA.
2 PLCS. (MODEL 7035)
.161 ± .005 DIA.
2 PLACES
C
B
A
FRONT PANEL
MOUNTING
(FRONT VIEW)

Model	A	B	C	D	E	F	G	H	I	J	K
7035	— —	1.125 ±.010	2.810 ±.015	3.718 +.030 −.000	1.859 +.015 −.000	.44 ±.01	2.156 +.030 −.000	3.105 ±.015	1.552 ±.008	.76 ±.01	1.5 ±.0
7045	3.50 ±.01	1.750 ±.005	2.810 ±.015	4.812 +.030 −.000	2.406 +.015 −.000	.63 ±.01	2.750 +.030 −.000	4.205 ±.015	2.102 ±.008	.95 ±.01	2.1 ±.0
7055	4.50 ±.01	2.250 ±.005	2.810 ±.015	5.875 +.030 −.000	2.937 +.015 −.000	.64 ±.01	3.156 +.030 −.000	5.240 ±.015	2.620 ±.008	.98 ±.01	2.5 ±.0

SELECTOR SWITCHES

2-Pole and 3-Pole



Switch	Dim. A	Dim. B	Bezel C
3″	3.187″	3.710″	3¼
5″	5.187″	6.540″	5¼

No. 18 (0.1695) Drill 4 Holes
Equally Spaced

ADAPTOR PANELS

Update obsolete equipment! OMEGA Adaptor Panels convert old, large cutouts to modern 3⅝″ square for solid state controllers.

Panel No.	Panel Size	Replaces	Price
PNL-101	4⅝ × 8¼	API (LFE) Series 228. Barber Colman Series 170, 520. West Series 100, 300, 700	$10.00
PNL-102	4¾ × 6⅞	API (LFE) Series 225, 226, 277. Barber Colman Series 72, 530. Honeywell Series R7272.	$10.00

Panel No.	Panel Size	Replaces	Price
PNL-103	7⅝ × 6⅝	APT (LFE) Series 700. Fenwal Series 524. Honeywell Series R7161, R7284, R7350. United Electric Series 1000. West Model J Series (Except "Q")	$10.0
PNL-104	7¾ × 8¼	Alnor Series N. Barber Colman Series 290. Fenwal Series 561, 580, 582.	$10.0
PNL-105	9¼ × 10¼	Barber Colman Series 470. Honeywell Pyrovane Series.	$15.0
PNL-106	7⅝ × 6⅝	Barber Colman Series 270. West Model JQ Series.	$10.0

Panel Punches and Hole Saws

Round Hole Punches

- No Reaming or Filing
- ¼″ or ⅜″ Pilot Hole
- Exact Size for Connectors

Heavy Duty—
Punches 16 Gage
060″ Steel

RHP-58 ⅝″ Dia. **$15**

For miniature round hole panel jacks, RMJ Series, see page G-17.

RHP-78 ⅞″ Dia. **$15**

For standard round hole panel jacks, RSJ Series, see page G-17.

Rectangular Hole Punches

- Rugged Industrial Design
- Square corners
- Sizes to mount all OMEGA connectors
- Keyed design assures alignment of punch and die. Simply drill a pilot hole and then punch out the exact shape for your connector.

Bench Presses also available.
Consult Sales Department.

CP-1 21⁄64″ × 43⁄64″
For • SMP connectors with SMACL adaptor clips
• MPJ connectors

CP-2 ⅜″ × 21⁄32″
For • NMP connectors with MACL adaptor clips

CP-3 17⁄32″ × 1 1⁄32″
For • OST and OGP connectors with SACL adaptor clips
• NOX and UOX connectors with XACL adaptor clips

CP-4 17⁄32″ × 1½″
For • OTP connectors with TACL adaptor clips

CP-5 ⅝″ × 1 3⁄16″
For • JP and SPJ panel connectors

Maximum aluminum panel thickness.
CP-1: 1⁄16″
Others: ⅛″

$90 each

Hole Saws

- For Panels Over ⅛″ Thick
- Replaceable Blades
- ¼″ Pilot Drill

Use your hand drill or drill press to fabricate jack panels with hole saws and round hole connectors. When the plate is too thick for punches, the saw is the solution. Connectors are on page G-17.

RHS - Complete assembly including saw, pilot drill and mandril.
⅝″ Dia. for RMJ Series
⅞″ Dia. for RSJ Series
Connectors, page G-17.

RHS-58 ⅝″ Dia.
RHS-78 ⅞″ Dia. **$10 each**

RS - Replacement saws
RS-58 ⅝″ Dia.
RS-78 ⅞″ Dia. **$5 each**

H

Wire: Thermocouple, RTD and Thermistor

Wire Reference Guide H-3
Uninsulated Fine Gage Thermocouple Wire H-6
Insulation Reference Guide H-10
Teflon Insulated Fine Gage Thermocouple Wire H-13
High Temperature Nextel Insulated Thermocouple Wire H-15
Insulated Wire Thermocouple, Thermistor and RTD H-18
Retractable Sensor Cable H-25
Braided Ceramic Sleeving H-27
Metal Overbraiding H-29
Multipair Extension Cable H-31
OMEGACLAD™ Metal Sheath Thermocouple Wire H-32
Wire Stripping Tools H-35

Applications and Reference Guide

Limits of Error

Thermocouple Grade Versus Extension Grade Wire

The Difference:

All wire, Thermocouple Grade and Extension Grade Wire, is manufactured to the industry-accepted standard ANSI MC 96.1 (1975), which specifies the maximum allowable thermoelectric deviation over a broad range of temperatures. (See Limits of Error Table)

Base metal thermocouple extension grade wire is made from the same materials as thermocouple wire; however, its use is restricted to a lower range of temperatures. Within its range, extension grade wire maintains the same limits of error as thermocouple grade wire.

Noble and refractory metal thermocouple extension grade wire is made from relatively inexpensive proprietary alloys created to simulate the thermoelectric behavior of the actual thermocouple elements over a limited range of temperatures. (See Table)

Limits of Error

Tables give the standard and special limits of error for thermocouple wire and extension grade thermocouple wire. The limits of error for each type of thermocouple apply only over the temperature range specified. (The limits of error in the tables do not include installation or system errors.) Furthermore, these limits of error should be applied only to standard published wire sizes. Where limits of error are given in percent (%) the percentage applies to the °C temperature being measured.
For example, if a J thermocouple is at a temperature of 200°C, then the limit of error is: 200°C × ¾% = ±1.5°C. If the measurement temperature is given in degrees Fahrenheit, then the following formula applies: (°F – 32) × % = Limits of Error, i.e., if temperature = 400°F then the limit of error is: (400 – 32°F) × ± ¾% = ±2.76°F.

LIMITS OF ERROR FOR THERMOCOUPLES[1]: REFERENCE JUNCTION 0°C

Thermocouple Type	Temperature Range °C	Temperature Range °F	Limits of Error[2] Standard (Whichever is greater)	Special (Whichever is greater)
T	0 to 350	32 to 662	±1.0°C or ±0.75%	±0.5°C or 0.4%
J	0 to 750	32 to 1382	±2.2°C or ±0.75%	±1.1°C or 0.4%
E	0 to 900	32 to 1652	±1.7°C or ±0.5%	±1.0°C or 0.4%
K	0 to 1250	32 to 2282	±2.2°C or ±0.75%	±1.1°C or 0.4%
R or S	0 to 1450	32 to 2642	±1.5°C or ±0.25%	±0.6°C or 0.1%
B	800 to 1700	1472 to 3092	±0.5%	Not Estab.
C*,G*,D*	0 to 425	32 to 797	±4.5°C	Not Estab.
	425 to 2320	797 to 4208	±1.0%	Not Estab.
	Sub-Zero Range[3]			
T	–200 to 0	–328 to 32	±1.0°C or ±1.5%	Not Estab.
E	–200 to 0	–328 to 32	±1.7°C or ±1.0%	Not Estab.
K	–200 to 0	–328 to 32	±2.2°C or ±2.0%	Not Estab.

EXTENSION GRADE THERMOCOUPLE WIRE: LIMITS OF ERROR[1]

Symbol	Alloy Combination	T/C Used With	Temperature Range °C	Temperature Range °F	Limits of Error[2] Standard (Whichever is greater)	Special (Whichever is greater)
JX	Iron/Constantan	J	0 to 200	32 to 392	±2.2°C or ±0.75%	±1.1°C or 0.4%
KX	Chromel/Alumel	K	0 to 200	32 to 392	±2.2°C or ±0.75%	±1.1°C or 0.4%
TX	Copper/Constantan	T	–60 to 100	–76 to 212	±1.0°C or ±0.75%	±0.5°C or 0.4%
EX	Chromel/Constantan	E	0 to 200	32 to 392	±1.7°C or ±0.5%	±1.0°C or 0.4%
SX,RX	Cu/Alloy 11	R,S[4]	0 to 150	32 to 300	±5.0°C or ±0.5%	Not Estab.
BX[5]	Cu/Cu	B[4]	0 to 100	32 to 212	–3.7°C or –0.4%	Not Estab.
GX*	200/226	W/W26Re	0 to 260	32 to 500	±0.14mV	Not Estab.
CX*	405/426	W5Re/W26Re	0 to 870	32 to 1600	±0.11mV	Not Estab.
DX*	203/225	W3Re/W25Re	0 to 260	32 to 500	±0.11 mV	Not Estab.

* Not ANSI symbol.

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[1] ANSI MC 96.1 (1975)
These limits are given only as a guide for discussion between purchaser and supplier.

[2] The limits of error of the thermocouples and extension wires are based on a Reference Junction temperature of 32°F (0°C). Does not include use or installation errors.

[3] Due to the characteristics of the materials, sub-zero limits of error for type J thermocouples are not listed.

[4] Due to the non-linearity of the noble metal temperature-emf curves, the error introduced into a thermocouple system by the compensating wire will be variable when expressed in degrees. The °F and °C limits of error are based on the following measuring junction temperatures:

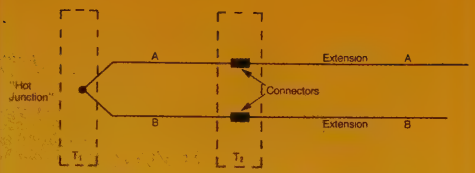
Type Wire	Measuring Junction Temperature
SX, RX	Greater than 1598°F (870°C)
BX	Greater than 1832°F (1000°C)

[5] Copper versus copper compensating extension wire is usable to 212°F (100°C) with deviation errors as indicated over the full range. No significant error is observed over the 32 to 122°F (0 to 50°C) portion of the range.

Size Dependent Data

Selection Note

When sizing your thermocouple, remember to make your thermocouple long enough so that the transition to extension grade wire is made at a point where the ambient temperature will not exceed the temperature limits for extension grade wire.



T_1 : Temperature Range as specified for thermocouple wire

T_2 : Temperature Range as specified for thermocouple extension grade wire

COMPARISON OF WIRE GAGES Standard Wire Gages in Approximate Decimals of an inch and mm.

American Wire Gage	Diameter Inches	Diameter Millimeters	American Wire Gage	Diameter Inches	Diameter Millimeters
1	0.2893	7.348	21	0.0285	0.7230
2	0.2576	6.544	22	0.0253	0.6438
3	0.2294	5.827	23	0.0226	0.5733
4	0.2043	5.189	24	0.0207	0.5106
5	0.1819	4.621	25	0.0179	0.4547
6	0.1620	4.115	26	0.0159	0.4049
7	0.1443	3.665	27	0.0142	0.3606
8	0.1285	3.264	28	0.0126	0.3211
9	0.1144	2.906	29	0.0113	0.2859
10	0.1019	2.588	30	0.0100	0.2546
11	0.0907	2.304	31	0.0089	0.2268
12	0.0808	2.053	32	0.0080	0.2019
13	0.0720	1.829	33	0.00708	0.178
14	0.0641	1.628	34	0.00630	0.152
15	0.0571	1.450	35	0.00561	0.138
16	0.0508	1.291	36	0.00500	0.127
17	0.0453	1.150	37	0.00445	0.1131
18	0.0403	1.024	38	0.00397	0.1007
19	0.0359	0.9116	39	0.00353	0.08969
20	0.0338	0.8118	40	0.00314	0.07987

RESISTANCE VS. WIRE DIAMETER Resistance in Ohms per Double Foot at 68°F

AWG No.	Diameter (inches)	Type K Chromel/ Alumel	Type J Iron/ Constantan	Type T Copper/ Constantan	Type E Chromel/ Constantan	Type S Pt/ Pt10% Rh	Type R Pt/ Pt13% Rh	Type C* W5% Re/ W26% Re	Type G* W/ W26% Re	Type D* W3% Re/ W25% Re
6	0.162	0.023	0.014	0.012	0.027	0.007	0.007	0.009	0.008	0.009
8	0.128	0.037	0.022	0.019	0.044	0.011	0.011	0.015	0.012	0.015
10	0.102	0.058	0.034	0.029	0.069	0.018	0.018	0.023	0.020	0.022
12	0.081	0.091	0.054	0.046	0.109	0.028	0.029	0.037	0.031	0.035
14	0.064	0.146	0.087	0.074	0.175	0.045	0.047	0.058	0.049	0.055
16	0.051	0.230	0.137	0.117	0.276	0.071	0.073	0.092	0.078	0.088
18	0.040	0.374	0.222	0.190	0.448	0.116	0.119	0.148	0.126	0.138
20	0.032	0.586	0.357	0.298	0.707	0.185	0.190	0.235	0.200	0.220
24	0.0201	1.490	0.878	0.7526	1.78	0.464	0.478	0.594	0.560	0.560
26	0.0159	2.381	1.405	1.204	2.836	0.740	0.760	0.945	0.803	0.890
30	0.0100	5.984	3.551	3.043	7.169	1.85	1.91	2.38	2.03	2.26
32	0.0080	9.524	5.599	4.758	11.31	1.96	3.04	3.8	3.22	3.60
34	0.0063	15.17	8.946	7.66	18.09	4.66	4.82	6.04	5.10	5.70
36	0.0050	24.08	14.20	12.17	28.76	7.40	7.64	9.6	8.16	9.10
38	0.0039	38.20	23.35	19.99	45.41	11.6	11.95	15.3	12.9	15.3
40	0.00315	60.88	37.01	31.64	73.57	18.6	19.3	24.4	20.6	23.0
44	0.0020	149.6	88.78	76.09	179.2	74.0	76.5	60.2	51.1	56.9
50	0.0010	598.4	355.1	304.3	716.9	185	191	240	204	227
56	0.00049	2408	1420	1217	2816	740	764	1000	850	945

*Not ANSI Symbol.

Reference Guide

Identification

Color Coding

Standard ANSI color coding is used on all insulated thermocouples wire and extension grade wire when the insulation permits. For some insulations a colored tracer is used to distinguish the calibration.

ANSI Letter Designations

Thermocouple and extension grade wires are specified by ANSI letter designations. Positive and negative legs are identified by the letter suffixes P and N respectively. Example: JP designates the positive leg (iron) of the Iron-Constantan pair.

CHARACTERISTICS TABLE

ANSI T/C	Symbol Single	Generic and Trade Names	Color Coding			Magnetic		Maximum Useful Temp. Range	EMF (MV) Over Useful Temp. Range	Average Sensitivity μV/°C	Environment (Bare Wire)
			Single	Overall T/C Wire	Overall Extension Grade Wire	Yes	No				
T	TP TN	Copper Constantan, Cupron, Advance	Blue Red	Brown	Blue		X X	°F -328 to 662 °C -200 to 350	-5.602 to 17.816	40.5	Mild Oxidizing, Reducing. Vacuum or Inert. Good where moisture is present.
J	JP JN	Iron Constantan, Cupron, Advance	White Red	Brown	Black	X	 X	°F 32 to 1382 °C 0 to 750	0 to 42.283	52.6	Reducing. Vacuum, Inert. Limited use in oxidizing at High Temperatures. Not recommended for low temps.
E	EP EN	Chromel, Tophel, T^{1} Thermokanthal KP Constantan, Cupron, Advance	Purple Red	Brown	Purple		X X	°F -328 to 1652 °C -200 to 900	-8.824 to 68.783	67.9	Oxidizing or Inert. Limited use in Vacuum or Reducing.
K	KP KN	Chromel, Tophel, T^{1} Thermokanthal KP Alumel, Nial, T^{2} Thermokanthal KN	Yellow Red	Brown	Yellow	 X	X	°F -328 to 2282 °C -200 to 1250	-5.973 to 50.633	38.8	Clean Oxidizing and Inert. Limited use in Vacuum or Reducing.
S	SP SN	Platinum 10% Rhodium Pure Platinum	Black Red		Green		X X	°F 32 to 2642 °C 0 to 1450	0 to 14.973	10.6	Oxidizing or Inert Atmos. Do not insert in metal tubes. Beware of contamination.
R	RP RN	Platinum 13% Rhodium Pure Platinum	Black Red		Green		X X	°F 32 to 2642 °C 0 to 1450	0 to 16.741	12.0	
B	BP BN	Platinum 30% Rhodium Platinum 6% Rhodium	Gray Red		Gray		X X	°F 32 to 3092 °C 0 to 1700	0 to 12.426	7.6	
C*	CP* CN*	Tunsten 5% Rhenium Tungsten 26% Rhenium	White/Red Trace Red		White/Red Trace		X X	°F 32 to 4208 °C 0 to 2320	0 to 37.066	16.6	Vacuum, Inert, Hydrogen Atmospheres. Beware of embrittlement.
G*	GP* GN*	Tungsten Tungsten 26% Rhenium	White/Blue Trace Red		White/Blue Trace		X X	°F 32 to 4208 °C 0 to 2320	0 to 38.564	16.0	
D*	DP* DN*	Tungsten 3% Rhenium Tungsten 25% Rhenium	White/Yellow Trace Red		White/Yellow Trace		X X	°F 32 to 4208 °C 0 to 2320	0 to 39.506	17.0	

*Not ANSI Symbol.

Temperature Dependent Data

MAXIMUM* LONG-TERM SERVICE TEMPERATURE FOR OMEGACLAD™

OMEGACLAD™ is a 3 part system composed of compacted ceramic insulation, thermocouple wire and metal sheath. Therefore, three factors determine the useful service temperature for OMEGACLAD™.

- Range for the thermocouple wire (see table—limits of error)
- Maximum service temperature of insulation. In the case of MgO, this is in excess of 3000°F (1650°C)
- Properties of the sheath material:

Thermocouple Type	Nominal Diameter	Sheath Material	
		Stainless Steel	Inconel
T	¼″	700°F (370°C)	700°F (370°C)
J	¼″	1400°F (770°C)	1400°F (770°C)
E	¼″	1650°F (900°C)	1650°F (900°C)
K	¼″	1650°F (900°C)	2100°F (1150°C)

*Based on limitations imposed by sheath or thermocouple wire, whichever is lower

Material	Melting Point	Continuous Max. Temp.	Tensile (PSI) Strength	
			at 200°F	at 1000°F
304 S.S.	2560°F	1650°F	68,000	15,000
316 S.S.	2500°F	1650°F	75,000	23,000
Inconel*	2550°F	2100°F	93,000	5,000

*Vacuum or Inert atmosphere only.

MAXIMUM LONG-TERM SERVICE TEMPERATURE FOR PROTECTED BARE WIRE THERMOCOUPLES OF VARIOUS WIRE DIAMETERS.

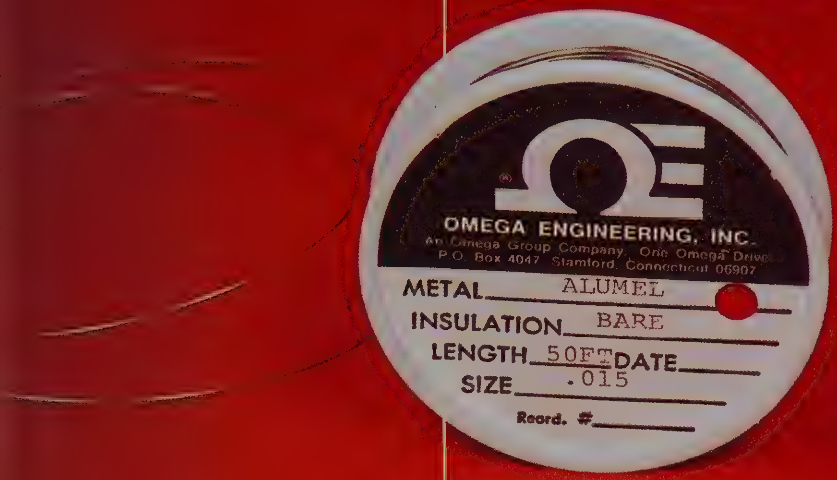
symbol	Alloy Combination	0.005″	0.015″	0.020″	0.032″
T	Copper-Constantan	400°F	400°F	400°F	500°F
J	Iron-Constantan	600°F	700°F	700°F	900°F
E	Chromel-Constantan	700°F	800°F	800°F	1000°F
K	Chromel-Alumel	1100°F	1600°F	1600°F	1800°F
R,S	Platinum-Rhodium			2700°F	
B	Platinum-Rhodium			3100°F	
C, G, D†	Tungsten-Rhenium*	3600°F	4200°F	4200°F	

†Not ANSI Symbols

Trade Names: Cupron Nial and Tophel-AMAX. / Advance, T1 and T2-Driver-Harris Co. / Chromel and Alumel-Hoskins Mfg. Co./Thermokanthal KP and Thermokanthal KN-Kanthal Co.

NOTE: The table above is only meant as a guide. Wire may be used to higher temperatures within overall range with subsequent decrease in lifetime. (ie: type K wire serviceable to 2300°F).

Thermocouple Wire


OMEGA ENGINEERING, INC.
An Omega Group Company, One Omega Drive
P.O. Box 4047, Stamford, Connecticut 06907
METAL ALUMEL
INSULATION BARE
LENGTH 50FT DATE
SIZE .015
Reord. #

OMEGA ENGINEERING, INC.
An Omega Group Company, One Omega Drive
P.O. Box 4047, Stamford, Connecticut 06907
METAL CHROMEL
INSULATION BARE
LENGTH 50FT DATE
SIZE .015
Reord. #

ORDER A MATCHED PAIR

INSULATED BASE METAL THERMOCOUPLE WIRE

Material	Wire Dia. (in.)	Cat. No.	Price 50 Foot Spools
Iron	0.001	SPIR-001	$13
	0.002	SPIR-002	13
	0.003	SPIR-003	13
	0.005	SPIR-005	10
	0.010	SPIR-010	10
	0.015	SPIR-015	10
	0.020	SPIR-020	16
	0.032	SPIR-032	16
Constantan*	0.001	SPCI-001	$13
	0.002	SPCI-002	13
	0.003	SPCI-003	13
	0.005	SPCI-005	10
	0.010	SPCI-010	10
	0.015	SPCI-015	10
	0.020	SPCI-020	16
	0.032	SPCI-032	16
Copper	0.001	SPCP-001	$13
	0.002	SPCP-002	13
	0.003	SPCP-003	13
	0.005	SPCP-005	10
	0.010	SPCP-010	10
	0.015	SPCP-015	10
	0.020	SPCP-020	16
	0.032	SPCP-032	16
Constantan*	0.001	SPCC-001	$13
	0.002	SPCC-002	13
	0.003	SPCC-003	13
	0.005	SPCC-005	10
	0.010	SPCC-010	10
	0.015	SPCC-015	10
	0.020	SPCC-020	16
	0.032	SPCC-032	16

	Material	Wire Dia. (in.)	Cat. No.	Price 50 Foot Spools
E	Chromel	0.0005	SPCH-0005	$31
		0.001	SPCH-001	13
		0.002	SPCH-002	13
		0.003	SPCH-003	13
		0.005	SPCH-005	10
		0.010	SPCH-010	10
		0.015	SPCH-015	10
		0.020	SPCH-020	16
		0.032	SPCH-032	16
	Constantan*	0.0005	SPCR-0005	$31
		0.001	SPCR-001	13
		0.002	SPCR-002	13
		0.003	SPCR-003	13
		0.005	SPCR-005	10
		0.010	SPCR-010	10
		0.015	SPCR-015	10
		0.020	SPCR-020	16
		0.032	SPCR-032	16
K	Chromel	0.0005	SPCH-0005	$31
		0.001	SPCH-001	13
		0.002	SPCH-002	13
		0.003	SPCH-003	13
		0.005	SPCH-005	10
		0.010	SPCH-010	10
		0.015	SPCH-015	10
		0.020	SPCH-020	16
		0.032	SPCH-032	16
	Alumel	0.0005	SPAL-0005	$31
		0.001	SPAL-001	13
		0.002	SPAL-002	13
		0.003	SPAL-003	13
		0.005	SPAL-005	10
		0.010	SPAL-010	10
		0.015	SPAL-015	10
		0.020	SPAL-020	16
		0.032	SPAL-032	16

*There are two forms of Constantan. Each form is composed of the same elements but the percent (%) of constituent elements differ. One is matched to Iron. The other is matched to Copper or Chromel. When ordering "matched pairs" be sure to specify SPCI with SPIR; SPCC with SPCP; SPCR with SPCH.

Fine Diameter Base Metal

In order to meet the immediate needs of science and industry for highest quality thermocouple wire in practical quantities at reasonable prices, OMEGA makes available thermocouple materials in a variety of wire sizes. The wire is supplied uninsulated on standard 3″ diameter plastic spools in continuous 50-foot lengths.

Sizes range from 0.0005″ to 0.032″ (0.012 mm) to (0.812 mm) diameter. The wire is supplied as single legs or in matched pairs to meet standard limits of error. Special limits of error wire available on request. The latter is sold only as matched pairs. Other wire sizes and quantities are available on special request. Write for quotation on price and delivery.

Available off-the-shelf for immediate delivery.

Thermocouple Wire

Fine Diameter Platinum-Rhodium

OMEGA ENGINEERING, INC.
An Omega Group Company, One Omega Drive
P.O. Box 4047 Stamford, Connecticut 06907
METAL PLATINUM PURE
INSULATION BARE
LENGTH 50FT DATE
SIZE 015
Reord. #
OMEGA ENGINEERING, INC.
An Omega Group Company, One Omega Drive
P.O. Box 4047 Stamford, Connecticut 06907
METAL PLATINUM 13%
INSULATION BARE
LENGTH 50FT DATE
SIZE 015
Reord. #

- **Matched Pairs**
- **Types S, R, and B**

For high resistance to oxidation and corrosion at high temperature, OMEGA offers the highest quality, uninsulated wire for three types of "noble metal" thermocouples. They are:

Type S: Platinum (–) vs. Platinum 10% Rhodium (+)
Type R: Platinum (–) vs. Platinum 13% Rhodium (+)
Type B: Platinum 6% Rhodium (–) vs. Platinum 30% Rhodium (+)

Types R and S are recommended for continuous use in oxidizing or inert atmospheres up to 2550°F (1398°C); short term exposures to 2700°F (1482°C). Type B is rated for continuous use up to 3100°F (1704°C) in oxidizing or inert atmospheres. When operating near these maximum temperatures, the heavier gage wire sizes are recommended.

All three thermocouple types may be used in a vacuum for short periods of time. Type B offers greater stability in such applications. They should not be used in reducing atmospheres or in atmospheres containing metallic or non-metallic vapors unless protected with non-metallic protection tubes. Do not insert directly into metallic protection tubes.

Sizes range from 0.001″ to 0.032″ (0.025 mm) to (0.812 mm) diameter. When requested, wire is supplied in matched pairs which meet or exceed standard limits of error. Special limits of error wire supplied on request and must be ordered as matched pairs.

UNINSULATED NOBLE METAL THERMOCOUPLE WIRE

Material	Wire Dia. (in.)	Cat. No.	Price/ Foot	Material	Wire Dia. (in.)	Cat. No.	Price/ Foot
Platinum (RN,SN)	0.001	SPPL-001	$ 4	Platinum 13% Rh (RP)	0.001	SP13RH-001	$ 4
	0.002	SPPL-002	4		0.002	SP13RH-002	4
	0.003	SPPL-003	4		0.003	SP13RH-003	4
	0.005	SPPL-005	5		0.005	SP13RH-005	5
	0.008	SPPL-008	12		0.008	SP13RH-008	12
	0.010	SPPL-010	17		0.010	SP13RH-010	17
	0.015	SPPL-015	36		0.015	SP13RH-015	36
	0.020	SPPL-020	59		0.020	SP13RH-020	59
	0.032	SPPL-032	145		0.032	SP13RH-032	145
Platinum 10% Rh (SP)	0.001	SP10RH-001	$ 4	Platinum 6% Rh (BN)	0.008	SP6RH-008	$ 12
	0.002	SP10RH-002	4		0.010	SP6RH-010	17
	0.003	SP10RH-003	4		0.015	SP6RH-015	36
	0.005	SP10RH-005	5		0.020	SP6RH-020	59
	0.008	SP10RH-008	12		0.032	SP6RH-032	145
	0.010	SP10RH-010	17	Platinum 30% Rh (BP)	0.008	SP30RH-008	$ 12
	0.015	SP10RH-015	36		0.010	SP30RH-010	17
	0.020	SP10RH-020	59		0.015	SP30RH-015	36
	0.032	SP10RH-032	145		0.020	SP30RH-020	59
					0.032	SP30RH-032	145

NEW! STOCKED FOR IMMEDIATE DELIVERY

INSULATED DUPLEX EXTENSION GRADE WIRE*

Material	Thermocouple Used With	AWG	Catalog Number	Maximum Temperature °F	Maximum Temperature °C	Price/ M Ft.
Cu-Alloy 11	R&S	24	EXTT-RS-24	392	200	$480
		24	EXGG-RS-24	392	200	390
		20	EXTT-RS-20	392	200	510
Cu-Cu	B	26	EXTT- B -26S	212	100	$400
		24	EXPP- B -24S	212	100	370
		20	EXGG- B -20	212	100	390

*See also duplex wire section.

Code: TT = Teflon GG = Glass
PP = Polyvinyl

Thermocouple Wire

Fine Diameter Tungsten-Rhenium

OMEGA ENGINEERING, INC.
An Omega Group Company. One Omega Drive
P.O. Box 4047. Stamford, Connecticut 06907
METAL TUNGSTEN 5%
INSULATION BARE
LENGTH 50FT DATE
SIZE 020
Reord. #
OMEGA ENGINEERING, INC.
An Omega Group Company. One Omega Drive
P.O. Box 4047. Stamford, Connecticut 06907
METAL TUNGSTEN 26%
INSULATION BARE
LENGTH 50FT DATE
SIZE 020
Reord. #

- **Matched Pairs**
- **Calibrated Accuracy Guaranteed**
- **Melting Point in Excess of 5000°F (2760°C)**

In stock for Immediate Delivery

UNINSULATED REFRACTORY METAL THERMOCOUPLE WIRE

Symbol*	Material	Wire Dia. (in.)	Catalog Number	Price/ Double Foot**
G	Tungsten vs Tungsten 26% Re	0.003	WW26-003	$ 7
		0.005	WW26-005	9
		0.010	WW26-010	17
		0.015	WW26-015	31
		0.020	WW26-020	44
C	Tungsten 5% Re vs Tungsten 26% Re	0.003	W5W26-003	$10
		0.005	W5W26-005	12
		0.010	W5W26-010	23
		0.015	W5W26-015	46
		0.020	W5W26-020	60
D	Tungsten 3% Re vs Tungsten 25% Re	0.003	W3W25-003	$10
		0.005	W3W25-005	12
		0.010	W3W25-010	23
		0.015	W3W25-015	46
		0.020	W3W25-020	60

*Not ANSI Symbol.

**Sold only as matched pairs. Minimum amount spooled, 5 ft.

EXTENSION GRADE WIRE

UNINSULATED LEAD WIRE FOR TUNGSTEN-RHENIUM THERMOCOUPLES

Symbol*	Thermocouple Used With	Catalog Number	Maximum Temperature °F	Maximum Temperature °C	Wire Size	Price/ Double Foot
GX	W vs W26%Re	EX-G-010	500	260	10 mil	35¢
		EX-G-020	500	260	20 mil	70¢
CX	W5%Re vs W26%Re	EX-C-010	1600	871	10 mil	35¢
		EX-C-020	1600	871	20 mil	70¢
DX	W3%Re vs W25%Re	EX-D-010	500	2600	10 mil	35¢
		EX-D-020	500	2600	20 mil	70¢

*Not ANSI Symbol.

SEE *INSULATED* EXTENSION GRADE WIRE IN DUPLEX WIRE SECTION

Tungsten-Rhenium thermocouple alloy combinations were developed to meet the requirements for measuring ultra-high temperatures in the 5000°F (2760°C) range.

OMEGA makes available three widely used Tungsten-Rhenium thermocouple alloy combinations:

Type G: Tungsten (+) vs.
Tungsten 26% Rhenium (–
Type C: Tungsten 5%
Rhenium (+) vs.
Tungsten 26% Rhenium (–
Type D: Tungsten 3%
Rhenium (+) vs.
Tungsten 25% Rhenium (–

In order to guarantee the limits of error, Tungsten-Rhenium thermocouple wire is sold only as a matched pair by the double foot. Because of the inherent brittleness of unalloyed Tungsten, Rhenium has been added to the positive leg of types C and D to improve handling characteristics. The average emf of types C and D is slightly less than that of the unalloyed type G.

All three thermocouple combinations can be used to 5000°F (2760°C) in hydrogen or inert gas atmospheres and in a vacuum. **They undergo rapid deterioration under oxidizing conditions and should not be used in air or atmospheres containing oxygen.**

Available From Stock; other wire sizes and large quantities available by quotation.

Thermocouple Wire

Omega Twelve Pak

Fine Diameter
Thermocouple Wire Assortment
Matched Pairs

$110

Immediate Delivery!

Complete Kit Contains
Twelve Fifty-Foot Spools

OMEGA ENGINEERING, INC.
METAL ALUMEL
INSULATION BARE
LENGTH 50FT DATE
SIZE .005
Recd. #
METAL CONSTANTAN
INSULATION BARE
LENGTH 50FT DATE
SIZE .003

- **Chromel vs Alumel**
- **Iron vs Constantan**
- **Copper vs Constantan**
- **Chromel vs Constantan**
- **Mixed Calibration Kits**

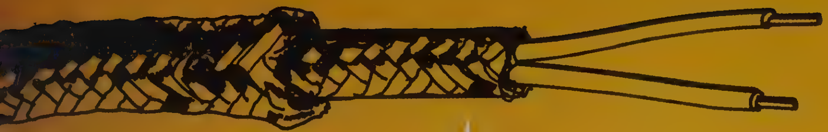
This kit is especially for the experimenter or lecturer who wishes to demonstrate response time or maximum service temperature as a function of wire diameter. The kit allows the user to select the best thermocouple for the application at hand.

OMEGA offers both universities and industry combination Twelve Paks, each containing six matched pairs of fine gage uninsulated thermocouple wire in fifty-foot lengths. Matched pairs of Chromel vs Alumel, Iron vs Constantan, Copper vs Constantan and Chromel vs Constantan are available as shown. Mixed Thermocouple Kits 5 and 6 now available.

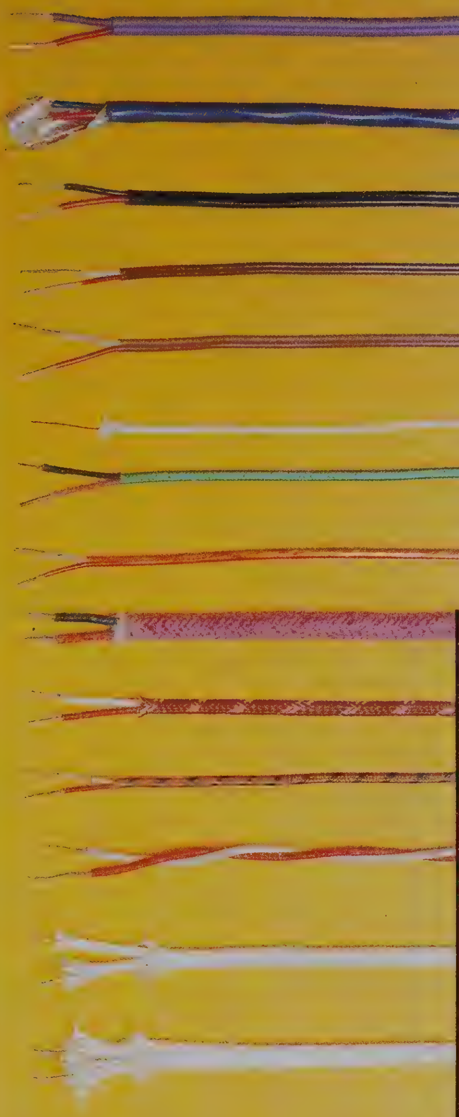
OMEGA's Twelve Pak kits 1-4 come equipped with the following six wire diameters: 0.001″ (0.02 mm), 0.002″ (0.05 mm), 0.003″ (0.07 mm), 0.005″ (0.012 mm), 0.010″ (0.25 mm) and 0.015″ (0.38 mm). At No Extra Charge, 0.020″ (0.50 mm) diameter wire may be substituted for any of the standard sizes. New Kits 5 and 6 come equipped with 0.003″ (0.07 mm), 0.005″ (0.12 mm) and 0.015″ (0.38 mm) wire.

FINE DIAMETER UNINSULATED WIRE KITS

		50 ft Spools Included in Kit					
	Material	**0.001″**	**0.002″**	**0.003″**	**0.005″**	**0.010″**	**0.015″**
KIT #1	Chromel vs. Alumel	✓	✓	✓	✓	✓	✓
KIT #2	Iron vs. Constantan	✓	✓	✓	✓	✓	✓
KIT #3	Copper vs. Constantan	✓	✓	✓	✓	✓	✓
KIT #4	Chromel vs. Constantan	✓	✓	✓	✓	✓	✓
KIT #5	Iron vs. Constantan and Chromel vs. Alumel			✓	✓		✓
KIT #6	Copper vs. Constantan and Chromel vs. Constantan			✓	✓		✓



Insulation



nsulation

The purpose of insulation is to mpose a dielectic material between adjacent thermocouple wires (primaries) to prevent shorts. Good nsulators are Teflon, ceramic, fiberglass, etc. Wire supplied in duplex orm includes an outer jacket which nay be extruded, wrapped, or stranded over the insulated primaries. This is referred to as the overall nsulation. A metal overbraid is also available for improved handling and abrasion characteristics.

See page H-29 for metal overbraiding.

Selection Criteria Duplex Wire

When recommended environmental constraints for insulation are exceeded, shorts develop between conductors resulting in erroneous thermocouple readings. A thermocouple will indicate the temperature at the short and not the temperature at the end measuring junction. In most cases, this situation will result in lower than expected readings. When several shorts occur, the temperature at the short closest to the instrumentation will be indicated.

When selecting thermocouple wire, the user should bear in mind temperature limitations on the thermocouple material itself (See Reference Guide) *as well as limitations on the insulation*. The following table serves as an insulation selection guide for acceptable temperature ranges as well as providing other important applications information critical to field use such as abrasion resistance, moisture resistance, flexibility, etc.

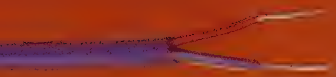
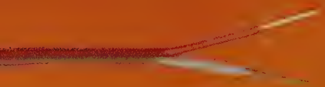
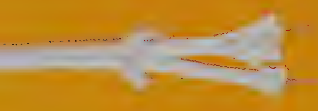
INSULATION CHARACTERISTICS

Material	Abrasion Resistance	Flexibility	Water Submersion	Temp. °F Max.	Temp. °F Min.	Resistance Solvent	Resistance Acid	Resistance Base	Resistance Flame	Resistance Humidity
Polyvinyl Chloride	Good	Excel.	Good	+ 221	– 40	Fair	Good	Good	Good	Good
Nylon	Excel.	Good	Poor	+ 300	– 65	Good	Poor	Good	Poor	Good
Kapton	Excel.	Good	Good	+ 600	– 450	Good	Good	Good	Good	Excel.
Teflon-PFA	Excel.	Good	Excel.	+ 500	– 450	Excel.	Excel.	Excel.	Excel.	Excel.
Teflon-FEP	Excel.	Good	Excel.	+ 400	– 450	Excel.	Excel.	Excel.	Excel.	Excel.
Silicone Rubber	Fair	Excel.	Good	+ 392	– 100	Fair	Poor	Good	Poor	Good
Glass	Poor	Good	Poor	+ 900	– 100	Excel.	Excel.	Excel.	Excel.	Fair
Refrasil	Poor	Good	Poor	+ 1600	– 100	Excel.	Good*	Good*	Excel	Poor
Nextel	Fair	Good	Poor	+ 2600	0	Excel.	Good*	Good*	Excel.	Fair

*Attacked by hydrofluoric, phosphoric acid and strong alkalies.

†Below 600°F

Insulation

	**PP**	**Polyvinyl (Conductors)** **Polyvinyl (Overall)** **Temp. Range:** **–40 to 221°F**	Color-coded polyvinyl is extruded over each bare wire. Polyvinyl jacket is applied over the insulated primaries. It is flexible within i temperature range, has good abrasion resistance and is unaffect by petroleum, alkalies, acids, and most solvents except ketones and esters.
	NN	**Nylon (Conductors)** **Nylon (Overall)** **Temp. Range:** **–65 to 300°F**	Nylon is extruded over each bare wire. Nylon overall jacket is applied over the insulated primaries.
	**TT**	**Teflon (Conductors)** **Teflon (Overall)** **Temp. Range:** **FEP: to 400°F** **PFA: to 500°F**	Teflon is extruded on each bare wire. Teflon jacket is extruded ove insulated primaries. Superior abrasion and moisture resistance u to 400°F (204°C) FEP or 500°F (260°C) PFA . Can be used for single reading up to 600°F (315°C).
	KK	**Kapton (Conductors)** **Kapton (Overall)** **Temp. Range: to 600°F**	Fused Kapton tape approximately 0.006″ (0.15 mm) thick is applied to each conductor. A 0.004″ (0.10 mm) jacket of fused Kapto tape is then applied over the insulated primaries. Kapton has excellent moisture and abrasion resistance, high dielectric strength (about 7,000 volts per mil) and retains much of its physical integrit after exposure to gamma radiation. A coating of FEP Teflon is add ed to the tape as an adhesive binding agent. The Teflon binder melts at approximately 500°F (260°C).
	TG	**Teflon (Conductors)** **Glass Braid: (Overall)** **Temp. Range:** **–100° to 500°F**	Teflon (PFA) is extruded over each conductor. Silicone impregnated glass approximately 0.005″ (0.12 mm) thick is overbraided onto the insulated primaries. Excellent moisture resistance to 500°F (260°C). Good abrasion resistance. May be used for a sing reading to 650°F (343°C).
	GG	**Glass Wrap or Silicone Impreg. Glass Braid (Conductors)** **Silicone Impreg. Glass Braid (Overall)** **Temp. Range:** **–100 to 900°F**	Each conductor is wrapped or covered with a single braid of glass yarn approximately 0.005″ (0.12 mm) thick and then impregnated with silicone varnish. The wrap resists fraying and is used on fine gage wire. The insulated primaries are then covered with a braid glass yarn 0.005″ (0.12 mm) thick. Suitable for continuous use to 900°F (482°C). The impregnation improves resistance to abrasio or moisture but is destroyed above 400°F (204°C).
	**XR**	**Refrasil** (Conductors)** **Refrasil Braid (Overall)** **Temp. Range:** **–100 to 1600°F**	Nextel, a high temperature alumina-boria-silica ceramic fiber, is braided on each conductor and then over the insulated primaries. Nextel's continuous service rating is 2600°F (1426°C) with a shor term rating to 3000°F (1648°C). For base metal thermocouple application, the construction is limited by the temperature of the thermocouple wire rather than by the ceramic braiding. Nextel ceramic fiber is NOT recommended for use with platinum thermocouples or in applications exposed to molten tin and copper, hydrofluoric or phosphoric acids, or strong alkalies. It is not color-coded.
	XC	**Nextel (Conductors)** **Nextel (Overall)** **Temp. Range: to 2600°F**	A braid of vitreous silica fiber is applied to each conductor and the over the insulated primaries. Suitable for use to 1600°F (871°C), depending upon the temperature limit of the wire. It will withstand temperatures to 1800°F (982°C) if not subjected to flexure or abr sion. It is not color-coded.

**Tradename H.I. Thompson

NEW! High Temperature Glass Insulation Available Soon!

Consult Sales Department

Properties of Teflon Insulation

OMEGA ENGINEERING, INC.
An Omega Group Company. One Omega Drive
P.O. Box 4047, Stamford, Connecticut 06907
METAL IRON CONSTANTAN
INSULATION TEFLON/TEFLON
LENGTH 50FT DATE
SIZE 20
Rcord. #
OMEGA ENGINEERING, INC.
An Omega Group Company. One Omega Drive
P.O. Box 4047, Stamford, Connecticut 06907
METAL IRON CONSTANTAN
INSULATION TEFLON/TEFLON
LENGTH 50FT DATE
SIZE 20
Rcord. #

The combination of chemical and physical properties of Teflon is a result of its true fluorocarbon structure. This unusual structure leads to a material which has an almost universal chemical inertness; complete insolubility in all known solvents below 572°F (300°C); excellent thermal stability; and unsurpassed electrical properties including low dielectric loss, low dielectric constant and high dielectric strength. Furthermore, Teflon does not embrittle at very low temperatures.

General Properties

	Teflon FEP	Teflon PFA
Chemical Resistance: hydrocarbons, ethylene glycol, battery acid, brake fluids, other chemicals	NO EFFECT	NO EFFECT
Resistance to weathering	NO EFFECT	NO EFFECT
Water absorption (ASTM D570)	0.1%	0.1%
Flammability (UL 83, Vertical Wire Flame Test)*	NO AFTER BURN	NO AFTER BURN
Melting Point °F	530	590
Melting Point °C	275	300
Upper Service Temperature °F 1500-2000 hrs. estimated	450	550
20,000 hrs.	400	500
Cold bend @ −65°C 2.5KV for 5 min.	PASS	PASS
Specific gravity	2.15	2.15

*Test does not represent all hazards present under actual fire conditions.

Mechanical and Electrical Properties

	Teflon FEP	Teflon PFA
Tensile strength, psi (73°F) ASTM D638	3,000	4,000
Elongation, % (73°F) ASTM D638	300	300
Flexural modulus, psi (73°F) ASTM D790	95,000	95,000
Flex life, MIT (7-9 mils) 180°F Flexes	100,000	200,000
Impact Strength, ft.lb/in.: ASTM D256 Room temperature	NO BREAK	NO BREAK
−65°F	10	10
Coefficient of friction, 10 fpm, 100 psi	0.3	0.2
Dynamic cut-through (lbs) Instron 1/16″ radius blade moving at 0.2″/min. (0.0031″ insulation thickness) 23°C	118	
75°C	73	
Dielectric constant, ASTM D50	2.1	2.1
Volume resistivity, ohm-cm ASTM D257	10^{18}	10^{18}
Dissipation Factor, ASTM D150, 10^{2}-10^{6} Hz	0.001	0.0004

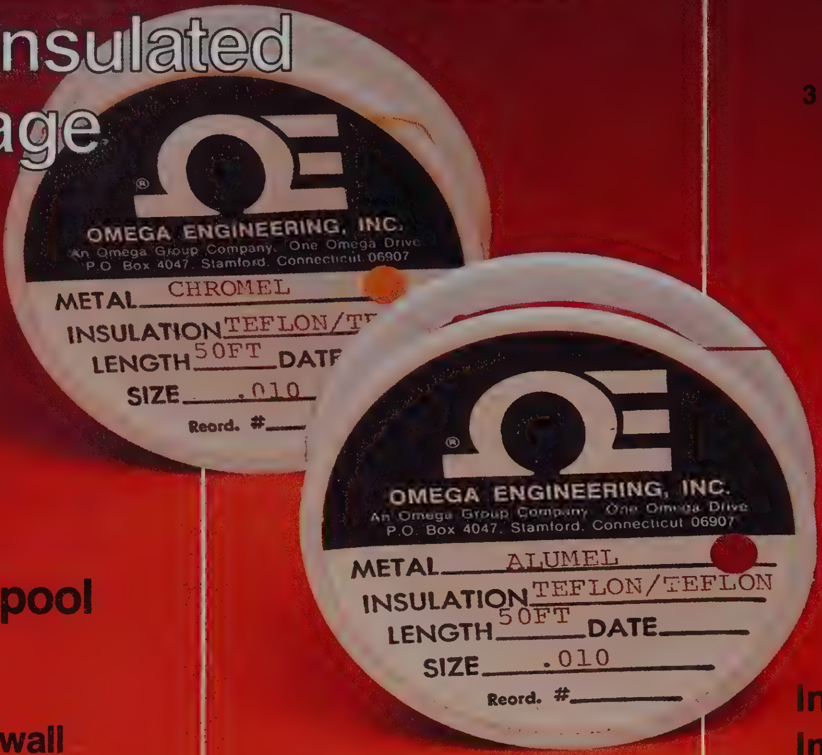
Environmental Properties

Resistance to:	Rating
Cold Flow or Cut Through	Fair
Ultraviolet Radiation	Excellent
Nuclear Radiation	Poor†
Electrical-Mechanical Stress Cracking	Excellent
Chemical-Mechanical Stress Cracking	Excellent

†In the absence of oxygen, radiation resistance is improved by a factor of more than 100.

Thermocouple Wire

Teflon Insulated Fine Gage Single


OMEGA ENGINEERING, INC.
An Omega Group Company, One Omega Drive
P.O. Box 4047, Stamford, Connecticut 06907
METAL CHROMEL
INSULATION TEFLON/TE
LENGTH 50FT DATE
SIZE .010
Recrd. #
OMEGA ENGINEERING, INC.
An Omega Group Company, One Omega Drive
P.O. Box 4047, Stamford, Connecticut 06907
METAL ALUMEL
INSULATION TEFLON/TEFLON
LENGTH 50FT DATE
SIZE .010
Recrd. #

$21 50

100 foot spool

OMEGA's thin-wall covering process guarantees continuous lengths up to 1,000 feet.

- 3 Mil Teflon Wall
- Single Strand
- Extruded PFA (Teflon)
- Color-coded
- Excellent in Vacuum
- Non-flammable
- Wire in Stock
  0.003″ (0.07 mm)
  0.005″ (0.12 mm)
  0.010″ (0.25 mm)
  0.015″ (0.38 mm)
- Available on 50 ft. spools for convenient small quantity needs
- Also Available 20 ga. and 24 ga. Consult Sales Department.

Price Table

Spool Size	Price
50 Ft.	$11.00
100 Ft.	21.50
500 Ft.	85.00

TEFLON INSULATED SINGLE

	Materials	Wire Dia. (in.)	Cat. No.	Color Code		Material	Wire Dia. (in.)	Cat. No.	Color Code
J	Iron	0.003	TFIR-003	White	E	Chromel	0.003	TFCH-003	Purple
		0.005	TFIR-005				0.005	TFCH-005	
		0.010	TFIR-010				0.010	TFCH-010	
		0.015	TFIR-015				0.015	TFCH-015	
	Constantan*	0.003	TFCI-003	Red		Constantan*	0.003	TFCR-003	Red
		0.005	TFCI-005				0.005	TFCR-005	
		0.010	TFCI-010				0.010	TFCR-010	
		0.015	TFCI-015				0.015	TFCR-015	
T	Copper	0.003	TFCP-003	Blue	K	Chromel	0.003	TFCY-003	Yellow
		0.005	TFCP-005				0.005	TFCY-005	
		0.010	TFCP-010				0.010	TFCY-010	
		0.015	TFCP-015				0.015	TFCY-015	
	Constanan*	0.003	TFCC-003	Red		Alumel	0.003	TFAL-003	Red
		0.005	TFCC-005				0.005	TFAL-005	
		0.010	TFCC-010				0.010	TFAL-010	
		0.015	TFCC-015				0.015	TFAL-015	

*Constantan is matched to either Iron, Copper or Chromel. When ordering "matched pairs" be sure to specify TFCI with TFIR; TFCC with TFCP; TFCR with TFCH.

Prices for large quantities*

10,000 ft. and over	12¢/foot
1,000 ft. to 9,999 ft.	15¢/foot
500 to 999 ft.	17¢/foot
100 to 499 ft.	21½¢/ft.
51 to 99 ft.	22¢/foot
Min. 50 foot spool @ $11	

*Prices for single conductor

3 mil Teflon wall over fine diameter single wire.

In Stock for Immediate Delivery

Order a "Matched Pair" Two 50 Foot Spools: $22

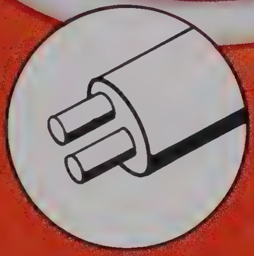
Thermocouple Wire

Teflon Insulated
Fine Gage
Duplex

OMEGA ENGINEERING, INC.
An Omega Group Company. One Omega Drive
P.O. Box 4047 Stamford Connecticut 06907
METAL COPPER CONSTANTAN
INSULATION TEFLON/TEFLON
LENGTH 500FT DATE
SIZE 36
Recrd. #
OMEGA ENGINEERING, INC.
An Omega Group Company. One Omega Drive
P.O. Box 4047 Stamford Connecticut 06907
METAL COPPER CONSTANTAN
INSULATION TEFLON/TEFLON
LENGTH 500FT DATE
SIZE 40
Recrd. #

Teflon over Teflon Construction

- 3 mil Teflon Wall On Each Conductor
- 3 mil Teflon Wall Overall Jacket
- Extruded PFA (Teflon)
- Color-coded
- Excellent At Low Temperatures And In Vacuum
- Non-flammable
- Available By The Foot Or Spool



DUPLEX CONSTRUCTION
3 mil Teflon on each Conductor
3 mil Teflon overall jacket

AWG	Nominal Dimensions	Ship Weight #/M ft.
30	0.022″ × 0.038″	4
36	0.017″ × 0.028″	2
40	0.015″ × 0.024″	1

TEFLON INSULATED DUPLEX WIRE

ANSI Symbol	Cat. No.	AWG No.	Price 50 Ft.	*Price M Feet	ANSI Symbol	Cat. No.	AWG No.	Price 50 Ft.	*Price M Feet
J	TT-J-30	30	$45	$450	E	TT-E-30	30	$51	$510
	TT-J-36	36	57	570		TT-E-36	36	63	630
	TT-J-40	40	79	790		TT-E-40	40	85	850
T	TT-T-30	30	$45	$450	K	TT-K-30	30	$51	$510
	TT-T-36	36	57	570		TT-K-36	36	63	630
	TT-T-40	40	79	790		TT-K-40	40	85	850

*To price intermediate quantities, see ordering information on page H-17.

Thermocouple Wire

Nextel 312 Ceramic Fiber Insulation

High Temperature, Ceramic Fiber Insulated Thermocouple Wire and Thermowell Elements!

- **Abrasion Resistant**
- **Nextel Fiber good to 2600°F (1426°C) Continuous Service**
- **Flexible**

Nextel, a high temperature, alumina-boria-silica ceramic fiber, is braided on each conductor and then over the parallel pair. Nextel's continuous service rating is 2600°F (1426°C) with a short-term rating to 3000°F (1648°C). For base metal thermocouple application, the construction is limited by the temperature of the thermocouple wire rather than by the ceramic braiding. Nextel ceramic fiber is NOT recommended for use with platinum thermocouples or in applications exposed to molten tin and copper, hydrofluoric or phosphoric acids, or strong alkalies.

ADDED PROTECTION

HIGH TEMPERATURE INCONEL OVERBRAIDING

OMEGA can add high temperature (1800°F) Inconel overbraiding to Nexte insulated thermocouple wire. The overbraiding adds abrasion resistance for oven profiling and improves handling characteristics.

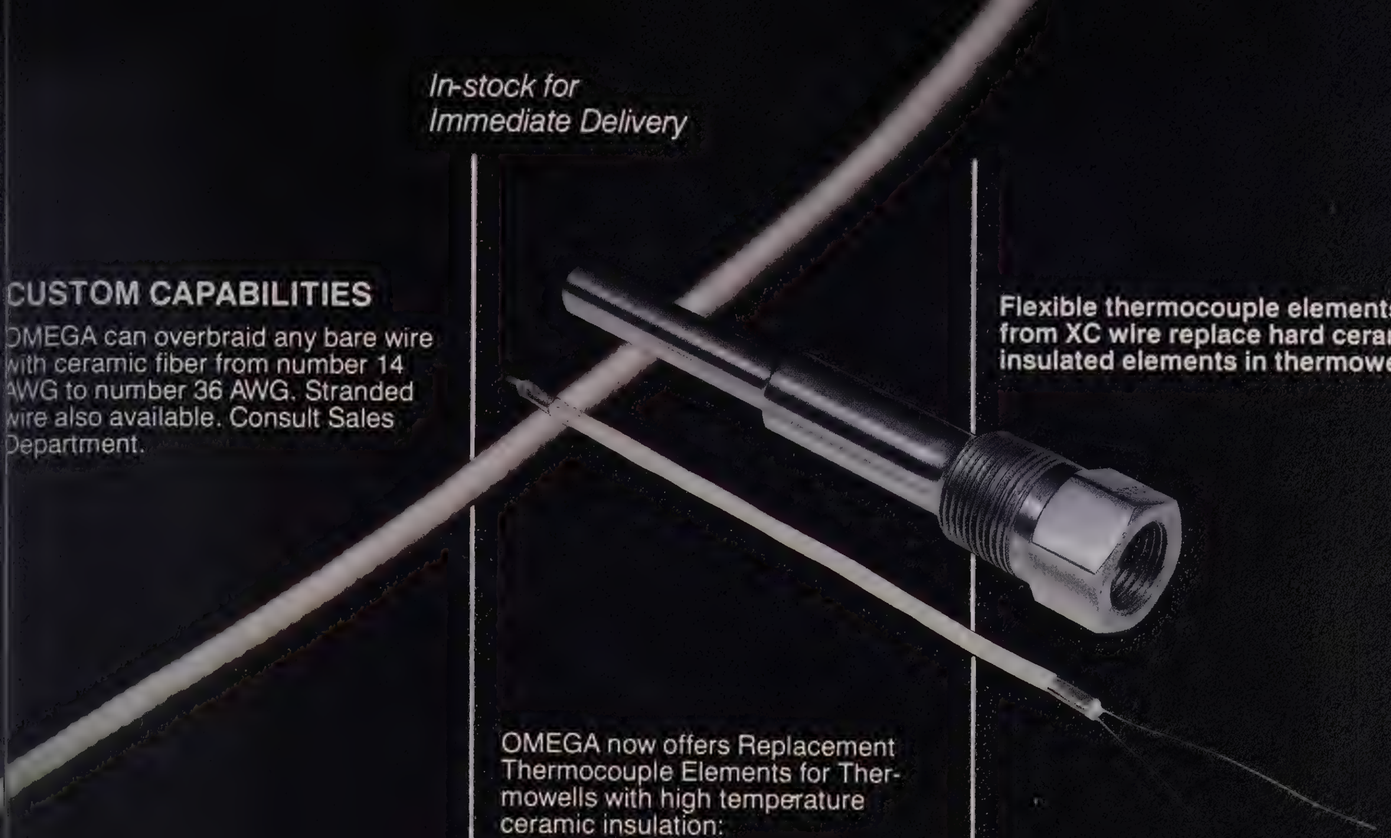
How to Order

Specify Catalog No. and length in feet. With Inconel overbraiding, add suffix "IB" to catalog number and specify "Inconel Overbraiding." Add price of overbraiding to price of wire.

PRICE FOR INCONEL 600 OVERBRAIDING

AWG No.	Price/ M Ft.
14	$600
20	400
24	300

See overbraiding pages in this section to price intermediate quantities.



In-stock for Immediate Delivery

CUSTOM CAPABILITIES

OMEGA can overbraid any bare wire with ceramic fiber from number 14 AWG to number 36 AWG. Stranded wire also available. Consult Sales Department.

Flexible thermocouple elements made from XC wire replace hard ceramic insulated elements in thermowells.

OMEGA now offers Replacement Thermocouple Elements for Thermowells with high temperature ceramic insulation:

- Oven Profiling
- Furnace Checks
- Exhaust Gases
- High Temperature Applications

How To Order:

HIGH TEMPERATURE THERMOWELL ELEMENTS

Catalog No.	Price First 12″ or Fraction	Price Add'l. 6″ or Fraction	AWG No.	Nominal O.D. (inch)	Wire Type
XC-14-☐-12 *	$8.00	$2.00	14	.140 × .200	Solid
XC-20-☐-12	7.00	1.50	20	.114 × .148	Solid
XC-24-☐-12	7.00	1.50	24	.100 × .125	Solid

T/C Calibration (J, K, E)

* Standard length 12″. Change last number to indicate desired length in inches.

HIGH TEMPERATURE CERAMIC INSULATED WIRE

Cat. No.	Price*/ M Feet	AWG No.	Wire Type	Nominal Overall Dimensions	Ship Wt. #/M Ft.
XC-K-14	$1680	14	Solid	.140 × .200	40
XC-K-20	850	20	Solid	.114 × .148	14
XC-K-24	500	24	Solid	.100 × .125	8
XC-E-14	1740	14	Solid	.140 × .200	40
XC-E-20	860	20	Solid	.114 × .148	14
XC-E-24	510	24	Solid	.100 × .125	8
XC-J-14	1560	14	Solid	.140 × .200	40
XC-J-20	750	20	Solid	.114 × .148	14
XC-J-24	470	24	Solid	.100 × .125	8

NEW!
Nextel Ceramic Sleeving
Now Available.
See Pages H-27 and H-28.

To price intermediate quantities of wire, consult Ordering Information page.

OMEGA ENGINEERING, INC.
An OMEGA Group Company
One Omega Drive · Box 4047 · Stamford, Conn. 06907 · (203) 322-1666 · Telex 996404 · Cable: OMEGA
HIGH QUALITY THERMOCOUPLE WIRE
Catalog # TT-J-20
T/C Type IR/Co AWG 20
Insulation TEFLON/TEFLON
Pos. White Neg.
Length 1000'
OMEGA ENGINEERING, INC.
An Omega Group Company One Omega Drive P.O. Box 4047 Stamford Connecticut 06907
METAL
INSULATION
LENGTH
SIZE
DATE
Record. #

Thermocouple Wire

Duplex Insulated

NEW!

Standard Length Spools

OMEGA thermocouple wire is available for off-the-shelf delivery on prepackaged spools for your convenience. You may combine different size spools of the same catalog number for quantity discounts. Fo example, if you purchased four 50 ft. spools of one particular wire, your price would be based on the total quantity of 200 ft.

Unless otherwise specified, all wire orders will be made up of combinations of standard length spools—always using the longest continuous lengths possible. For example, if you ordered 700 ft. of wire of the same catalog number, you would receive one spool of 500 ft. and one spool of 200 ft.

By purchasing OMEGA prepackaged wire you are assured of fast delivery and continuous wire lengths— no scraps! The minimum spool length is 25 ft.

Spool Pricing

1. Determine price per 1000 ft. spool
2. Establish price category for the standard lengths available:

$$25\text{ ft.} = \frac{\text{Price per M ft.}}{1000} \times 2.5$$

$$50\text{ ft.} = \frac{\text{Price per M ft.}}{1000} \times 2$$

$$100\text{ ft.} = \frac{\text{Price per M ft.}}{1000} \times 1.75$$

$$200\text{ ft.} = \frac{\text{Price per M ft.}}{1000} \times 1.5$$

$$500\text{ ft.} = \frac{\text{Price per M ft.}}{1000} \times 1$$

$$1000\text{ ft.} = \text{Price per M ft. (Net)}$$

3. To determine total cost, use established price category (from step 2) times total length.
4. Examples:

Wire Type: EXPP-J-14 @ $460/M	
50 ft.	**EXPP-J-14** @ $.46/ft. x 2 = $.92/ft. (**$46.00** per 50 ft. spool)
100 ft.	**EXPP-J-14** @ .46/ft. x 1.75 = .81/ft. (**$81.00** per 100 ft. spool
150 ft.	**EXPP-J-14** @ .46/ft. x 1.75 = .81/ft. (**$121.50** per 150 ft. lot) ***Note:*** *Customer will receive one 100 ft. spool and one 50 ft. spool.*
200 ft.	**EXPP-J-14** @ .46/ft. x 1.5 = .69/ft. (**$138.00** per 200 ft. spool
300 ft.	**EXPP-J-14** @ .46/ft. x 1.5 = .69/ft. (**$207.00** per 300 ft. lot) ***Note:*** *Customer will receive one 200 ft. spool and one 100 ft. spool.*
500 ft.	**EXPP-J-14** @ .46/ft. x 1 = .46/ft. (**$230.00** per 500 ft. spool)

Note: *For orders over 3000 feet of the same catalog number, contact the Sales Department for quantity discounts.*

Thermocouple Wire
Duplex Insulated

Duplex Insulated
Iron/Constantan
—Duplex—
ANSI Type J

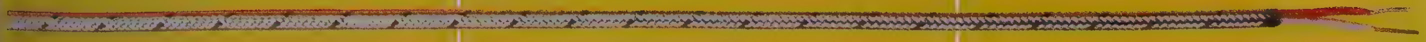
J

ANSI Color Code: Positive Wire, White; Negative Wire, Red; Overall, Brown

Insulation	AWG No.	Cat. No.	Price M Feet	Type Wire′	Insulation		Max. Temp.		Nominal Size	Wt.† #/M Ft.
					Conductor	Overall	°F	°C		
Ceramic	20	XC-J-20	$750	Solid	Nextel Ceramic	Nextel Ceramic	1400	760	.109 × .156	14
Glass	14	GG-J-14	680	Solid	Glass Braid	Glass Braid	900	482	.098 × .170	43
	20	GG-J-20	310	Solid	Glass Braid	Glass Braid	900	482	.054 × .099	9
	20	GG-J-20S	480	7 × 28	Glass Braid	Glass Braid	900	482	.059 × .109	9
	24	GG-J-24	240	Solid	Glass Braid	Glass Braid	900	482	.052 × .076	5
	24	GG-J-24S	410	7 × 32	Glass Braid	Glass Braid	900	482	.057 × .086	5
	28	GG-J-28	200	Solid	Glass Braid	Glass Braid	900	482	.034 × .055	3
	30	GG-J-30	220	Solid	Glass Wrap	Glass Braid	900	482	.034 × .052	2
	36	GG-J-36	310	Solid	Glass Wrap	Glass Braid	900	482	.029 × .038	2
Teflon Glass	30	TG-J-30	490	Solid	Teflon	Glass Braid	500	260	.034 × .050	2
	36	TG-J-36	630	Solid	Teflon	Glass Braid	500	260	.026 × .036	2
	40	TG-J-40	920	Solid	Teflon	Glass Braid	500	260	.026 × .031	2
Teflon	20	TT-J-20	540	Solid	Teflon	Teflon	400	204	.068 × .116	11
	20	TT-J-20S	590	7 × 28	Teflon	Teflon	400	204	.073 × .126	11
	24	TT-J-24	300	Solid	Teflon	Teflon	400	204	.056 × .092	7
	24	TT-J-24S	470	7 × 32	Teflon	Teflon	400	204	.063 × .102	7
	30	TT-J-30	450	Solid	Teflon	Teflon	500	260	.022 × .038	2
	36	TT-J-36	570	Solid	Teflon	Teflon	500	260	.017 × .028	2
	40	TT-J-40	790	Solid	Teflon	Teflon	500	260	.015 × .024	2
Polymers	20	NN-J-20	210	Solid	Nylon	Nylon	300	148	.064 × .109	9
	30	NN-J-30	160	Solid	Nylon	Nylon	300	148	.041 × .065	2
	24	PR-J-24	130	Solid	Polyvinyl	(Rip Cord)	221	105	.046 × .086	5

†Weight of spool and wire, rounded up to next highest lb. Does not include packing material.

Now you can add Stainless Steel, Inconel or Tinned Copper Overbraiding to your insulated thermocouple wire…



…we will cover any insulated wire in our handbook with metal overbraiding to protect against wear and abrasion. Also adds durability and electrical shielding for improved performance.

See pages H-29 and H-30 for complete information.

Thermocouple Wire

Duplex Insulated

K

Duplex Insulated
Chromel/Alumel
—Duplex—
ANSI Type K

ANSI Color Code: Positive Wire, Yellow; Negative Wire, Red; Overall, Brown

Insulation	AWG No.	Cat. No.	Price M Feet	Type Wire	Insulation		Max. Temp.		Nominal Size	Wt.† #/M Ft.
					Conductor	Overall	°F	°C		
Ceramic*	20	XC-K-20	$850	Solid	Nextel Ceramic	Nextel Ceramic	2300	1250	.109 × .156	14
	20	XR-K-20	950	Solid	Refrasil	Refrasil	1600	870	.096 × .152	14
Glass	20	GG-K-20	410	Solid	Glass Braid	Glass Braid	900	482	.054 × .099	9
	20	GG-K-20S	740	7 × 28	Glass Braid	Glass Braid	900	482	.059 × .109	9
	24	GG-K-24	290	Solid	Glass Braid	Glass Braid	900	482	.052 × .076	5
	24	GG-K-24S	550	7 × 32	Glass Braid	Glass Braid	900	482	.057 × .086	5
	26	GG-K-26	230	Solid	Glass Braid	Glass Braid	900	482	.040 × .063	4
	28	GG-K-28	230	Solid	Glass Braid	Glass Braid	900	482	.034 × .055	3
	30	GG-K-30	240	Solid	Glass Wrap	Glass Braid	900	482	.034 × .052	3
	36	GG-K-36	320	Solid	Glass Wrap	Glass Braid	900	482	.029 × .038	2
Teflon Glass	30	TG-K-30	530	Solid	Teflon	Glass Braid	500	260	.034 × .050	2
	36	TG-K-36	850	Solid	Teflon	Glass Braid	500	260	.026 × .036	2
	40	TG-K-40	800	Solid	Teflon	Glass Braid	500	260	.026 × .031	2
Teflon	20	TT-K-20	720	Solid	Teflon	Teflon	500	260	.068 × .116	11
	20	TT-K-20S	850	7 × 28	Teflon	Teflon	500	260	.073 × .126	11
	24	TT-K-24	370	Solid	Teflon	Teflon	500	260	.056 × .092	6
	24	TT-K-24S	620	7 × 32	Teflon	Teflon	500	260	.063 × .102	6
	30	TT-K-30	510	Solid	Teflon	Teflon	500	260	.022 × .038	2
	36	TT-K-36	630	Solid	Teflon	Teflon	500	260	.017 × .028	2
	40	TT-K-40	850	Solid	Teflon	Teflon	500	260	.015 × .024	2
Polymers	20	NN-K-20	390	Solid	Nylon	Nylon	300	148	.064 × .109	9
	30	NN-K-30	150	Solid	Nylon	Nylon	300	148	.041 × .065	2
	24	PR-K-24	230	Solid	Polyvinyl	(Rip Cord)	221	105	.046 × .086	5
	20	KK-K-20	850	Solid	Kapton	Kapton	600	315	.057 × .103	11
	24	KK-K-24	580	Solid	Kapton	Kapton	600	315	.045 × .079	6

†Weight of spool and wire, rounded up to next highest lb. Does not include packing material.

*Not Color-coded

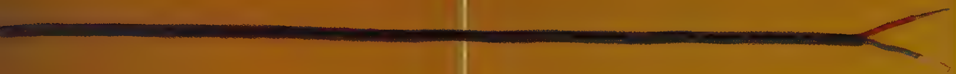
Also Available!

Gold/Atomic Iron Au-0.07% Fe

Now in Stock!

Gold/0.07% Atomic Iron in .010," 0.005," and 0.003" Diameters.
For use with Chromel-P at Cryogenic Temperatures.

Pre-made Thermocouples also available. Consult Sales Department for quotation.



Duplex Insulated Copper/Constantan —Duplex— ANSI Type T

T

ANSI Color Code: Positive Wire, Blue; Negative Wire, Red; Overall, Brown

Insulation	AWG No.	Cat. No.	Price M Feet	Type Wire	Insulation Conductor	Insulation Overall	Max. Temp. °F	Max. Temp. °C	Nominal Size	Wt.† #/M Ft.
Glass	20	GG-T-20	320	Solid	Glass Braid	Glass Braid	662	350	.054 × .099	9
	20	GG-T-20S	460	7 × 28	Glass Braid	Glass Braid	662	350	.059 × .109	9
	24	GG-T-24	240	Solid	Glass Braid	Glass Braid	662	350	.052 × .076	5
	24	GG-T-24S	380	7 × 32	Glass Braid	Glass Braid	662	350	.057 × .086	5
	28	GG-T-28	240	Solid	Glass Braid	Glass Braid	662	350	.034 × .055	3
	30	GG-T-30	210	Solid	Glass Wrap	Glass Braid	662	350	.034 × .052	3
Teflon Glass	30	TG-T-30	480	Solid	Teflon	Glass Braid	500	260	.034 × .050	2
	36	TG-T-36	640	Solid	Teflon	Glass Braid	500	260	.026 × .036	2
	40	TG-T-40	790	Solid	Teflon	Glass Braid	500	260	.026 × .031	2
Teflon	20	TT-T-20	460	Solid	Teflon	Teflon	500	260	.063 × .116	11
	20	TT-T-20S	570	7 × 28	Teflon	Teflon	500	260	.073 × .126	11
	24	TT-T-24	330	Solid	Teflon	Teflon	500	260	.056 × .092	7
	24	TT-T-24S	450	7 × 32	Teflon	Teflon	500	260	.063 × .102	7
	30	TT-T-30	450	Solid	Teflon	Teflon	500	260	.022 × .038	2
	36	TT-T-36	570	Solid	Teflon	Teflon	500	260	.017 × .028	2
	40	TT-T-40	790	Solid	Teflon	Teflon	500	260	.015 × .024	2
Polymers	20	NN-T-20	290	Solid	Nylon	Nylon	300	148	.064 × .109	9
	24	NN-T-24	280	Solid	Nylon	Nylon	300	148	.052 × .086	7
	30	NN-T-30	180	Solid	Nylon	Nylon	300	148	.041 × .065	2
	24	PP-T-24	240	Solid	Polyvinyl	Polyvinyl	221	105	.075 × .120	10
	24	PP-T-24S	300	7 × 32	Polyvinyl	Polyvinyl	221	105	.080 × .130	10
	24	PR-T-24	140	Solid	Polyvinyl	(Rip Cord)	221	105	.046 × .086	5

Duplex Insulated Chromel/Constantan —Duplex— ANSI Type E

E

ANSI Color Code: Positive Wire, Purple; Negative Wire, Red; Overall, Brown

Insulation	AWG No.	Cat. No.	Price M Feet	Type Wire	Insulation Conductor	Insulation Overall	Max. Temp. °F	Max. Temp. °C	Nominal Size	Wt.† #/M Ft.
Ceramic*	20	XC-E-20	$ 860	Solid	Nextel Ceramic	Nextel Ceramic	1600	871	.109 × .156	14
Glass	20	GG-E-20	410	Solid	Glass Braid	Glass Braid	900	482	.054 × .099	9
	20	GG-E-20S	670	7 × 28	Glass Braid	Glass Braid	900	482	.059 × .109	9
	24	GG-E-24	310	Solid	Glass Braid	Glass Braid	900	482	.052 × .076	5
	24	GG-E-24S	500	7 × 32	Glass Braid	Glass Braid	900	482	.057 × .086	5
	26	GG-E-26	390	Solid	Glass Braid	Glass Braid	900	482	.040 × .065	4
	30	GG-E-30	330	Solid	Glass Wrap	Glass Braid	900	482	.034 × .052	3
	36	GG-E-36	390	Solid	Glass Wrap	Glass Braid	900	482	.029 × .038	2
Teflon	20	TT-E-20S	770	7 × 28	Teflon	Teflon	500	260	.073 × .126	11
	24	TT-E-24S	630	7 × 32	Teflon	Teflon	500	260	.063 × .102	6
	30	TT-E-30	510	Solid	Teflon	Teflon	500	260	.022 × .038	2
	36	TT-E-36	630	Solid	Teflon	Teflon	500	260	.017 × .028	2
	40	TT-E-40	850	Solid	Teflon	Teflon	500	260	.015 × .024	2

†Weight of spool and wire, rounded up to next highest lb. Does not include packing material.

*Not Color-Coded.

Thermocouple Wire

Duplex Extension Grade

JX

Extension Grade
Iron/Constantan
—Duplex—
ANSI Type JX

ANSI Color Code: Positive Wire, White; Negative Wire, Red; Overall, Black

Insulation	AWG No.	Cat. No.	Price M Feet	Type Wire	Insulation Conductor	Insulation Overall	Max. Temp. °F	Max. Temp. °C	Nominal Size	Wt.† #/M Ft.
Glass	16	EXGG-J-16	440	Solid	Glass Braid	Glass Braid	392	200	.089 × .141	23
Teflon	16	EXTT-J-16	600	Solid	Teflon	Teflon	392	200	.086 × .152	21
	20	EXTT-J-20	390	Solid	Teflon	Teflon	392	200	.068 × .116	11
	24	EXTT-J-24	290	Solid	Teflon	Teflon	392	200	.056 × .092	7
Polyvinyl	14	EXPP-J-14	460	Solid	Polyvinyl	Polyvinyl	221	105	.134 × .288	34
	16	EXPP-J-16	310	Solid	Polyvinyl	Polyvinyl	221	105	.123 × .207	26
	16	EXPP-J-16S	470	7 × 25	Polyvinyl	Polyvinyl	221	105	.139 × .226	26
	20	EXPP-J-20	180	Solid	Polyvinyl	Polyvinyl	221	105	.095 × .151	16
	20	EXPP-J-20S	320	7 × 28	Polyvinyl	Polyvinyl	221	105	.123 × .175	17
	20	EXPP-J-20-TSH	190	Solid	Polyvinyl	Polyvinyl	221	105	.174 O.D.	21
	24	EXPP-J-24S	290	7 × 32	Polyvinyl	Polyvinyl	221	105	.082 × .134	12
Polymers	16	EXPN-J-16	360	Solid	Polyvinyl	Nylon	300	148	.101 × .182	24
	20	EXPN-J-20	210	Solid	Polyvinyl	Nylon	300	148	.090 × .155	9

TX

Extension Grade
Copper/Constantan
—Duplex—
ANSI Type TX

ANSI Color Code: Positive Wire, Blue; Negative Wire, Red; Overall, Blue

Insulation	AWG No.	Cat. No.	Price M Feet	Type Wire	Insulation Conductor	Insulation Overall	Max. Temp. °F	Max. Temp. °C	Nominal Size	Wt.† #/M Ft.
Teflon	16	EXTT-T-16	$590	Solid	Teflon	Teflon	212	100	.086 × .152	21
	20	EXTT-T-20	390	Solid	Teflon	Teflon	212	100	.068 × .116	11
	24	EXTT-T-24	280	Solid	Teflon	Teflon	212	100	.056 × .092	7
Polyvinyl	14	EXPP-T-14	520	Solid	Polyvinyl	Polyvinyl	221	105	.134 × .288	36
	16	EXPP-T-16	330	Solid	Polyvinyl	Polyvinyl	221	105	.123 × .207	26
	20	EXPP-T-20	190	Solid	Polyvinyl	Polyvinyl	221	105	.095 × .151	16
	20	EXPP-T-20S	340	7 × 28	Polyvinyl	Polyvinyl	221	105	.123 × .175	16
	20	EXPP-T-20-TSH	340	Solid*	Polyvinyl	Polyvinyl	221	105	.174	21

†Weight of spool and wire, rounded up to next highest lb. Does not include packing material.

* Twisted then shielded with Aluminum Mylar. Copper drain wire.

Extension Grade Chromel/Alumel —Duplex— ANSI Type KX

KX

ANSI Color Code: Positive Wire, Yellow; Negative Wire, Red; Overall, Yellow

Insulation	AWG No.	Cat. No.	Price M Feet	Type Wire	Insulation		Max. Temp.		Nominal Size	Wt.† #/M Ft.
					Conductor	Overall	°F	°C		
Glass	16	EXGG-K-16	590	Solid	Glass Braid	Glass Braid	392	200	.089 × .141	23
Teflon	16	EXTT-K-16	760	Solid	Teflon	Teflon	392	200	.086 × .152	21
	20	EXTT-K-20	470	Solid	Teflon	Teflon	392	200	.068 × .116	11
	24	EXTT-K-24	330	Solid	Teflon	Teflon	392	200	.056 × .092	7
Polyvinyl	14	EXPP-K-14	690	Solid	Polyvinyl	Polyvinyl	221	105	.134 × .288	36
	16	EXPP-K-16	490	Solid	Polyvinyl	Polyvinyl	221	105	.123 × .207	26
	16	EXPP-K-16S	690	7 × 25	Polyvinyl	Polyvinyl	221	105	.139 × .226	26
	18	EXPP-K-18S	770	7 × 26	Polyvinyl	Polyvinyl	221	105	.138 × .205	22
	20	EXPP-K-20	230	Solid	Polyvinyl	Polyvinyl	221	105	.095 × .151	16
	20	EXPP-K-20S	420	7 × 28	Polyvinyl	Polyvinyl	221	105	.123 × .175	16
	20	EXPP-K-20-TSH	260	Solid*	Polyvinyl	Polyvinyl	221	105	.174	21
	24	EXPP-K-24S	370	7 × 32	Polyvinyl	Polyvinyl	221	105	.082 × .134	11
Polymer	16	EXPN-K-16	530	Solid	Polyvinyl	Nylon	221	105	.101 × .182	24
	20	EXPN-K-20	280	Solid	Polyvinyl	Nylon	221	105	.090 × .155	9

*Twisted then shielded with Aluminum Mylar. Copper drain wire.

Extension Grade Chromel/Constantan —Duplex— ANSI Type EX

EX

ANSI Color Code: Positive Wire, Purple; Negative Wire, Red; Overall, Purple

Insulation	AWG No.	Cat. No.	Price M Feet	Type Wire	Insulation		Max. Temp.		Nominal Size	Wt.† #/M Ft.
					Conductor	Overall	°F	°C		
Teflon	16	EXTT-E-16	780	Solid	Teflon	Teflon	392	200	.086 × .152	21
	20	EXTT-E-20	470	Solid	Teflon	Teflon	392	200	.068 × .116	11
	24	EXTT-E-24	330	Solid	Teflon	Teflon	392	200	.056 × .092	7
Polyvinyl	16	EXPP-E-16	530	Solid	Polyvinyl	Polyvinyl	221	105	.123 × .207	26
	18	EXPP-E-18S	510	7 × 26	Polyvinyl	Polyvinyl	221	105	.138 × .205	22
	20	EXPP-E-20	260	Solid	Polyvinyl	Polyvinyl	221	105	.095 × .151	17
	24	EXPP-E-24S	350	7 × 32	Polyvinyl	Polyvinyl	221	105	.082 × .134	12

Extension Grade Copper/Alloy —Duplex— ANSI Type RX and SX

RX/SX

Compensating Extension Wires for Platinum(–)/Platinum-Rhodium(+) Thermocouples
ANSI Color Code: Positive Wire, Black; Negative Wire, Red; Overall, Green

Insulation	AWG No.	Cat. No.	Price M Feet	Type Wire	Insulation		Max. Temp.		Nominal Size	Wt.† #/M Ft.
					Conductor	Overall	°F	°C		
Glass	20	EXGG-RS-20	400	Solid	Glass Braid	Glass Braid	302	150	.057 × .099	9
	24	EXGG-RS-24	390	Solid	Glass Braid	Glass Braid	302	150	.049 × .078	5
Teflon	20	EXTT-RS-20	510	Solid	Teflon	Teflon	302	150	.068 × .116	11
	24	EXTT-RS-24	480	Solid	Teflon	Teflon	302	150	.056 × .092	7
Polyvinyl	16	EXPP-RS-16	390	Solid	Polyvinyl	Polyvinyl	221	105	.118 × .195	26

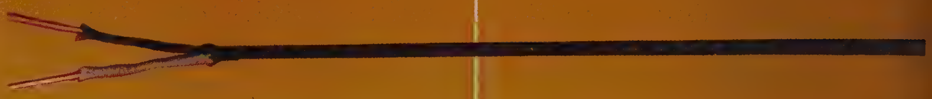
†Weight of spool and wire, rounded up to next highest lb. Does not include packing material.

Thermocouple Wire

Duplex Extension Grade

BX

Extension Grade
Copper/Copper
—Duplex—
ANSI Type BX



Compensating Extension Wires for Platinum 6% Rhodium (–)/Platinum 30% Rhodium (+) Thermocouples
ANSI Color Code: Positive Wire, Gray; Negative Wire, Red; Overall, Gray*

Insulation	AWG No.	Cat. No.	Price M Feet	Type Wire	Insulation		Max. Temp.		Nominal Size	Wt.† #/M Ft.
					Conductor	Overall	°F	°C		
Glass	20	EXGG-B-20	$390	Solid	Glass Braid	Glass Braid	212	100	.058 × .100	9
Teflon	26	EXTT-B-26S	400	7 × 34	Teflon	Teflon	212	100	.042 × .068	5
Polyvinyl	24	EXPP-B-24S	370	7 × 32	Polyvinyl	Polyvinyl	212	100	.082 × .134	12

*Black on GG wire

CX

Extension Grade
W5%Re/W26%Re
—Duplex—
Type CX

Compensating Extension Wires for W5%Re/W26%Re Thermocouples. Alloy type 405/426.
Color Code: Positive Wire, White/Red Trace; Negative Wire, Red; Overall, White/Red Trace

Insulation	AWG No.	Cat. No.	Price M Feet	Type Wire	Insulation		Max. Temp.		Nominal Size	Wt.† #/M Ft.
					Conductor	Overall	°F	°C		
Ceramic*	20	EXXC-C-24	$900	Solid	Nextel Ceramic	Nextel Ceramic	1600	871	.100 × .125	8
Glass	24	EXGG-C-24	460	Solid	Glass Braid	Glass Braid	900	482	.040 × .078	7
Bare	24	EX-C-24	290	Solid	None	None	1600	871	.020	3
	30	EX-C-30	150	Solid	None	None	1600	871	.010	2

*Not Color-coded

DX

Extension Grade
W3%Re/W25%Re
—Duplex—
Type DX

Compensating Extension Wires for W3%Re/W25%Re Thermocouples. Alloy type 203/225.
Color Code: Positive Wire, White/Yellow Trace; Negative Wire, Red; Overall, White/Yellow Trace

Insulation	AWG No.	Cat. No.	Price M Feet	Type Wire	Insulation		Max. Temp.		Nominal Size	Wt.† #/M Ft.
					Conductor	Overall	°F	°C		
Glass	24	EXGG-D-24	$460	Solid	Glass Braid	Glass Braid	500	260	.045 × .078	5
Bare	24	EX-D-24	290	Solid	None	None	500	260	.020 O.D.	3
	30	EX-D-30	150	Solid	None	None	500	260	.010 O.D.	2

GX

Extension Grade
W/W26%Re
—Duplex—
Type GX

Compensating Extension Wires for W/W26%Re Thermocouples: Alloy Type 200/226
Color Code: Positive Wire, White/Blue Trace; Negative Wire, Red; Overall, White/Blue Trace

Insulation	AWG No.	Cat. No.	Price M Feet	Type Wire	Insulation		Max. Temp.		Nominal Size	Wt.† #/M Ft.
					Conductor	Overall	°F	°C		
Glass	24	EXGG-G-24	$460	Solid	Glass Braid	Glass Braid	500	260	.045 × .078	5
Bare	24	EX-G-24	290	Solid	None	None	500	260	.020 O.D.	3
	30	EX-G-30	150	Solid	None	None	500	260	.010 O.D.	2

†Weight of spool and wire, rounded up to next highest lb.
Does not include packing material.

Thermocouple Wire
Special Limits of Error

J

CAT. NO.	AWG NO.	PRICE PER M FEET
GG-J-20SLE	20	$410
GG-J-24SLE	24	310
TT-J-20SLE	20	700
TT-J-24SLE	24	360

SPECIAL LIMITS OF ERROR FOR THERMOCOUPLES:[1]

Thermocouple Type	Temperature Range °C	Temperature Range °F	Special Limits of Error[2]
T	0 to 350	32 to 662	±0.5°C or 0.4%
J	0 to 750	32 to 1382	±1.1°C or 0.4%
E	0 to 900	32 to 1652	±1.0°C or 0.4%
K	0 to 1250	32 to 2282	±1.1°C or 0.4%

[1] ANSI MC96.1 (1975)
[2] Whichever is greater.

K

CAT. NO.	AWG NO.	PRICE PER M FEET
GG-K-20SLE	20	$530
GG-K-24SLE	24	380
TT-K-20SLE	20	930
TT-K-24SLE	24	480

T

CAT. NO.	AWG NO.	PRICE PER M FEET
GG-T-20SLE	20	$410
GG-T-24SLE	24	310
TT-T-20SLE	20	590
TT-T-24SLE	24	430

E

CAT. NO.	AWG NO.	PRICE PER M FEET
GG-E-20SLE	20	$540
GG-E-24SLE	24	410
TT-E-20SLE	20	800
TT-E-24SLE	24	390

GG-Glass/Glass TT-Teflon/Teflon
To order intermediate quantities, see ordering information page H-17.

Thermistor and RTD

Nickel Plated Copper Wire[*]

Color Code: 2 Cu—R/Bk[†]; 3 Cu—R/Bk/Bk; 4 Cu—R/R/Bk/Bk

Insulation	AWG No.	Cat. No.	Price M Feet	# of Conductors	Type Wire	Insulation		Max. Temp.		Nominal Size	Wt.[†] #/M Ft.
						Conductor	Overall	°F	°C		
Glass	20	EXGG-2CU-20	$370	2	Solid	Glass Braid	Glass Braid	900	482	0.050 × 0.100	9
Teflon	26	EXTT-2CU-26S	480	2	7 × 34	Teflon	Teflon	500	260	0.042 × 0.068	5
	26	EXTT-3CU-26S	650	3	7 × 34	Teflon	Teflon	500	260	0.072	7
	26	EXTT-4CU-26S	700	4	7 × 34	Teflon	Teflon	500	260	0.082	9
Polyvinyl	24	EXPP-2CU-24S	390	2	7 × 32	Polyvinyl	Polyvinyl	221	105	0.082 × 0.134	10
	24	EXPP-3CU-24S	520	3	7 × 32	Polyvinyl	Polyvinyl	221	105	0.166	14

[*] can be welded
[†] Also can be Red/Grey

Retractable Sensor Cables

Color coded, Spring coiled Retractable for Thermocouples, RTD's and Thermistors

Features:

- ANSI type J, K, T, and E thermocouple calibrations and 3 wire copper for RTD's and Thermistors
- Expansion ratio up to 500%—1 foot of cable stretches to 5 feet
- TPE Plastic Jacket for indoor and outdoor use to 220°F (104°C)
- Retracted coil lengths of 1, 2, 3 and 4 feet with 6" straight ends
- Ideal for use with hand held and benchstand electronic indicators

OMEGA's Retractable Sensor Cables are color coded, and spring coiled, for use with Thermocouples, RTD's and Thermistors.

To achieve a superior jacket construction, OMEGA has employed the latest in jacketing material: TPE (Thermoplastic Elastomer), a unique family of thermoplastics which exhibits characteristics previously found only in rubber compounds. TPE is extremely tough and flexible, and has excellent abrasion resistance. Special construction technique yields an expansion rate up to 500%.

OMEGA's RETRACTABLE SENSOR CABLES are specifically recommended for use with electronic-type indicators, either panel, hand held or bench-type models. The cables should not be used with self-powered, unamplified analog panel meters, such as OMEGA Series 4000 and 7000 pyrometers. The Retractable Sensor Cables have hundreds of applications: oscillating machinery, hand held surface probes, or wherever retractable sensor cables are required.

Specifications

Insulation: TPE (Thermoplastic Elastomer)

Calibrations: ANSI type J, K, T, E, and 3 wire copper for RTD's and Thermistors

Thermocouple Wire Conformance: Standard Limits of Error, per ANSI MC 96.1 (1975)

Temperature Rating: −22° to 220°F (−30° to 105°C)

Construction: 28 gage stranded wire (7 strand x 36 gage)

Length: Coiled lengths of 1, 2, 3, or 4 feet with 6 inch straight ends. Straight wire length per foot of retracted coil = 8.8 feet; maximum expanded length of 1 foot coil = approximately 5 feet.

Length Tolerance: ±10%

Cable Outside Diameter: Thermocouple cable = 0.165" (4.2 mm); RTD and thermistor cable = 0.175" (4.4 mm)

Color Coding: Thermocouple/RTD Industry Standards

COLOR CODE OF CABLES

	ANSI Type	Jacket	+ Wire	– Wire
Iron/Constantan	J	Black	White	Red
Chromel/Alumel	K	Yellow	Yellow	Red
Copper/Constantan	T	Blue	Blue	Red
Chromel/Constantan	E	Purple	Purple	Red
Copper (3 Wire)	RTD/TH	White	2 Black	Red

TYPICAL RESISTANCE OF CABLES

Ohms Per Running Foot of Cable* 1 Foot Coiled (5 Feet Extended)				Ohms Per Foot of Wire (Three Wires Per Cable)
J (Black)	K (Yellow)	T (Blue)	E (Purple)	RTD and Thermistor (White)
16.3	27.5	14.0	33.1	0.57

HOW TO ORDER:

1. Fill the 1st box [ ] with desired ANSI calibration. Use ANSI symbols "J", "K", "T", "E" for thermocouple calibration; "RTD" for resistance temperature detector; or "TH" for thermistor.
2. Fill in 2nd box [ ] with retracted coil length in feet (1, 2, 3, or 4 feet).
3. Fill in 3rd box [ ] with termination style number (one end).
4. Fill in 4th box [ ] with termination style number (other end).

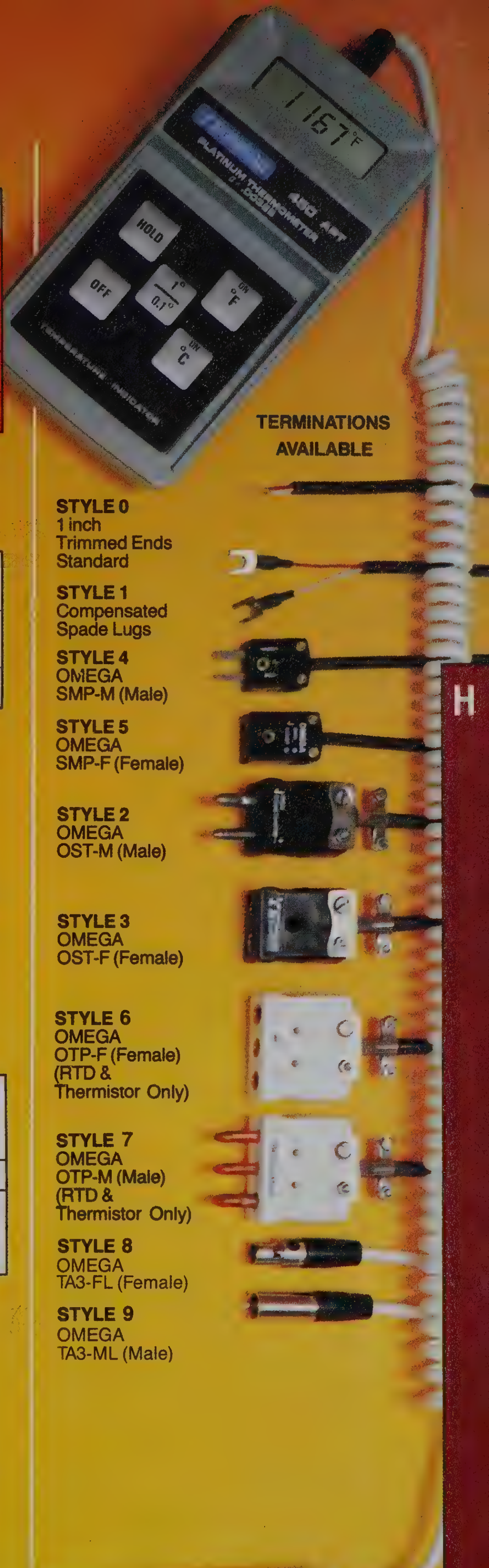
IN STOCK FOR IMMEDIATE DELIVERY

Sensor Type	Catalog Number	Price Per Retracted Foot		Add'l Price for Each Termination Style				
		First Foot	Each Add'l Foot	0	1	2-5	6-7	8-9
Thermocouple	RSC-[ ]-[ ]-[ ]-[ ]	$8.50	$5.00	N/C	$2	$5	$7	—
3 Wire (RTD) and Thermistor)	RSC-[ ]-[ ]-[ ]-[ ]	7.00	4.00	N/C	5	5	7	$6.25

Termination Style No. (One End)
Termination Style No. (Other End)
Retracted Length in Feet (1, 2, 3, or 4 feet)
Type of Sensor (J, K, T, E; or RTD, TH)

ORDERING EXAMPLE:

RSC-K-2-1-2 This catalog number calls out a 2 foot, Type K Retractable Sensor Cable with spade lugs on one end and a male OST connector on the other end.
Price = ($8.50 + 5.00 + 2.00 + 5.00) = $20.50



TERMINATIONS AVAILABLE

STYLE 0
1 inch
Trimmed Ends
Standard

STYLE 1
Compensated
Spade Lugs

STYLE 4
OMEGA
SMP-M (Male)

STYLE 5
OMEGA
SMP-F (Female)

STYLE 2
OMEGA
OST-M (Male)

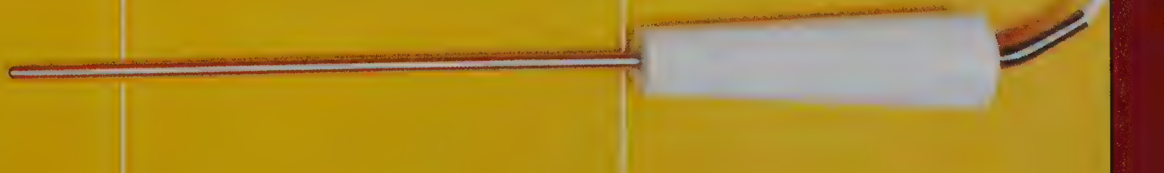
STYLE 3
OMEGA
OST-F (Female)

STYLE 6
OMEGA
OTP-F (Female)
(RTD &
Thermistor Only)

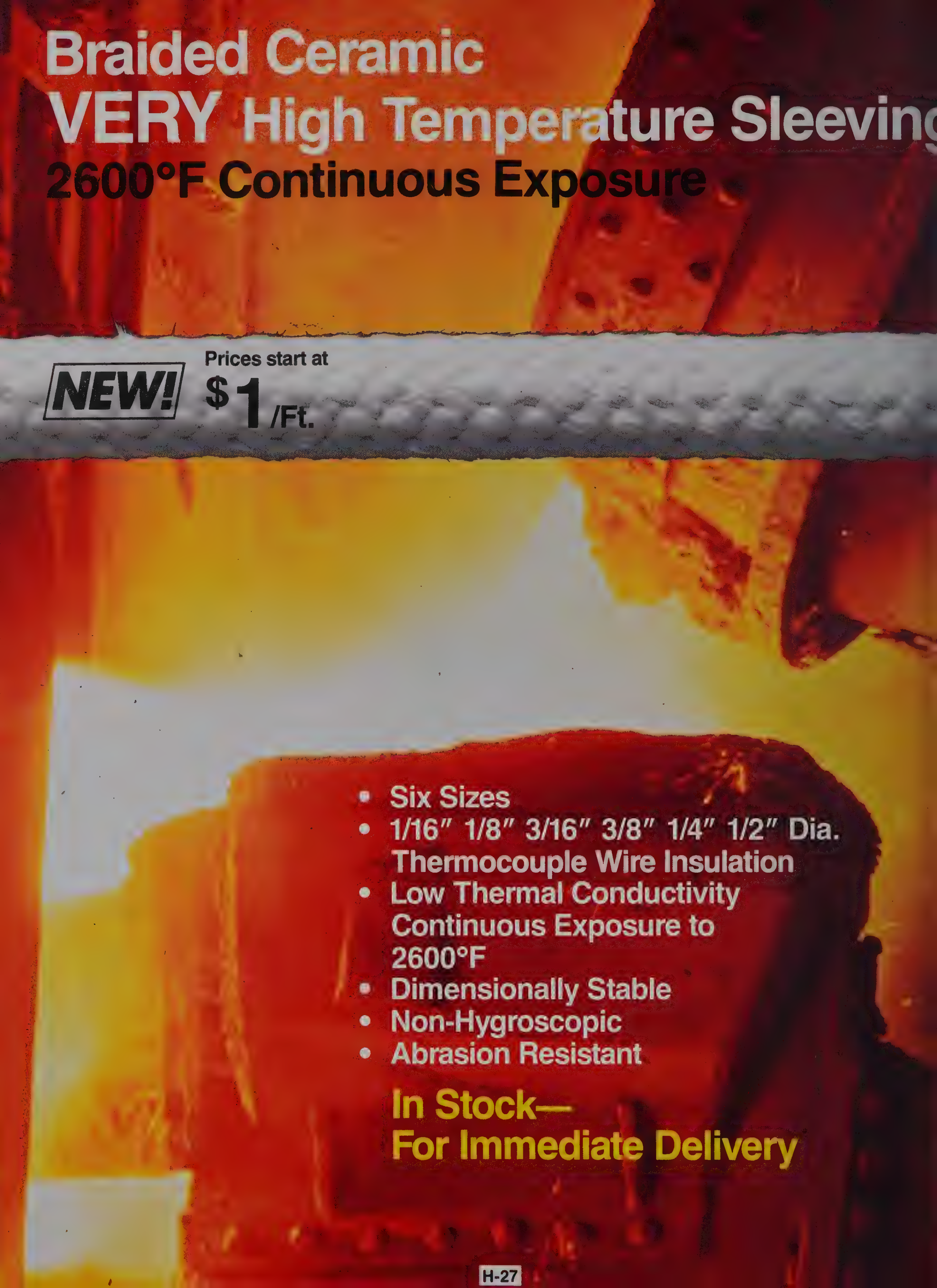
STYLE 7
OMEGA
OTP-M (Male)
(RTD &
Thermistor Only)

STYLE 8
OMEGA
TA3-FL (Female)

STYLE 9
OMEGA
TA3-ML (Male)



Braided Ceramic
VERY High Temperature Sleeving
2600°F Continuous Exposure



NEW!

Prices start at

$1/Ft.

- Six Sizes
- 1/16″ 1/8″ 3/16″ 3/8″ 1/4″ 1/2″ Dia. Thermocouple Wire Insulation
- Low Thermal Conductivity Continuous Exposure to 2600°F
- Dimensionally Stable
- Non-Hygroscopic
- Abrasion Resistant

In Stock—
For Immediate Delivery

Nextel 312* is an Alumina-Borica-Silica Fiber that is braided without the aid of organic, glass or metal inserts. This sleeving retains strength and flexibility at continuous exposure to 2600°F. Short exposures to 3000°F can be tolerated. Most common metals (except Molten Copper and Tin) do not attack the fibers.

Because Nextel 312 Ceramic Fibers contain no residual acids or chlorides, there's no chemical present to corrode or etch the wires. Even in a test involving exposure to 96 percent relative humidity, no noticeable electrolytic corrosion was detected.

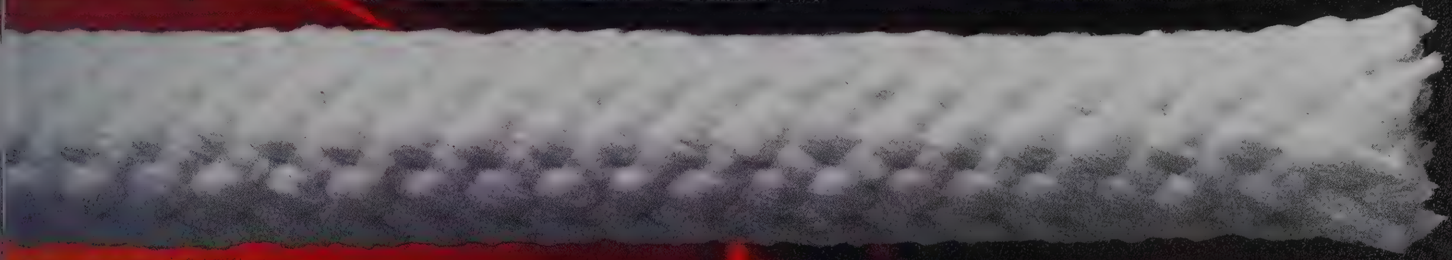
*Nextel is a registered trademark of 3M Company.

Effects of Chemicals on Sleeving

Chemical	Percent Strength Retention*
NH_4OH (ammonium hydroxide)	90
HCl (hydrochloric acid)	90
H_2SO_4 (sulfuric acid)	50
H_3PO_4 (phosphoric acid)	less than 1
$NaOH$ (sodium hydroxide)	less than 1
KOH (potassium hydroxide)	less than 1
CaO (calcium oxide-lime)	40

*After exposure to 10 percent chemical baths

2600°F Continuous Exposure Braided Ceramic Sleeving



How to Order

PART NO.	PRICE PER FT.	NOMINAL INSIDE DIAMETER	COVERAGE* %	PICKS PER INCH	YARDS/LB.
XC-116	$1.00	1/16	92	13	85
XC-18	1.50	1/8	83	13	36
XC-316	1.75	3/16	91	11	27
XC-14	2.00	1/4	81	12	25
XC-38	2.50	3/8	72	10	17
XC-12	3.50	1/2	71	11	12

*% coverage is the sleeve length when it is expanded to the nominal inside diameter as compared to the relaxed length. (Measured length × % coverage = actual length covered.)

NOTE: The length is measured when the sleeving is empty and in a relaxed state.

Overbraiding

Stainless Steel, Inconel and

OMEGA will overbraid any thermocouple wire with either Inconel 600, 304 Stainless Steel or Tinned Copper Overbraiding (see applicable gages in the tables). Both Inconel and Stainless Steel Overbraiding add durability, flexibility, and abrasion protection to your valuable thermocouples thus lengthening the life of your thermocouple by protecting it from wear.

Low cost Tinned Copper Overbraiding provides electrical shielding with the added benefit of durability, flexibility, and abrasion protection.

At no extra charge, OMEGA color codes the Stainless Steel, Inconel and Tinned Copper Overbraid with a fiberglass strand for easy thermocouple type identification.

Stainless Steel Overbraid:
Recommended for temperatures to 1400°F (760°C) continuous; 1600°F (871°C) short duration.

Inconel Overbraid:
Recommended for temperatures to 1800°F (982°C) continuous; 2100°F (1148°C) short duration.

Tinned Copper Overbraid:
Recommended for temperatures up to 400°F (204°C) continuous.

Pricing:
To compute the total cost, ADD the price of the Overbraiding from the tables to the price of the thermocouple wire.

To Construct Catalog Number:
For **Stainless Steel Overbraid** add the suffix "SB" to the wire part number and specify Stainless Steel Overbraid on your order.
For **Inconel Overbraid,** add the suffix "IB" to the wire part number and specify Inconel Overbraid on your order.
For **Tinned Copper Overbraid,** add suffix "TCB" to the wire part number and specify Tinned Copper Overbraid on your order.

Availability:
"*Off-the-shelf*" in many cases. Please consult Sales Department.

Minimum Order:
Less than 100 ft., consult Sales Department.

Ordering Example:
GG-K-20-TCB, "Tinned Copper Overbraid" designates 20-gage, Chromel-Alumel thermocouple wire (type K) with glass insulation around each conductor and overall, which is then overbraided with tinned copper.

Note:
All Stainless Steel, Inconel and Tinned Copper Overbraid is color coded unless otherwise specified.

Tinned Copper

Price List for 304 Stainless Steel Overbraid

Wire Gage	Price/Ft. 25' Spool	Price/Ft. 50' Spool	Price/Ft. 100' Spool	Price/Ft. 200' Spool	Price/M Ft. 500' & Over*
14	$.95	$.76	$.66	$.57	$380/M ft.
16	.90	.72	.63	.54	360/M ft.
20	.60	.48	.42	.36	240/M ft.
24	.45	.36	.31	.27	180/M ft.
30	.45	.36	.31	.27	180/M ft.
36	.45	.36	.31	.27	180/M ft.

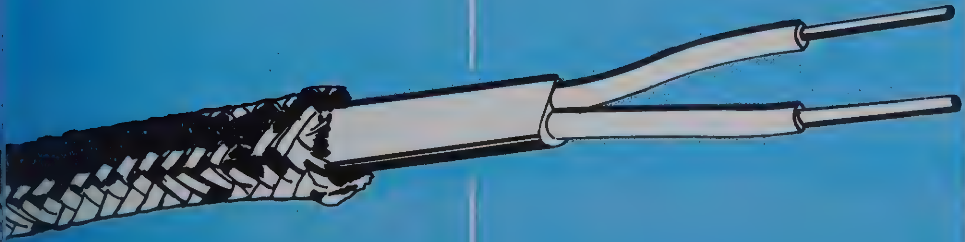
Price List for Inconel 600 Overbraid

Wire Gage	Price/Ft. 25' Spool	Price/Ft. 50' Spool	Price/Ft. 100' Spool	Price/Ft. 200' Spool	Price/M Ft. 500' & Over*
14	$1.50	$1.20	$1.05	$.90	$600/M ft.
16	1.37	1.10	.96	.82	550/M ft.
20	1.00	.80	.70	.60	400/M ft.
24	.75	.60	.52	.45	300/M ft.
30	.75	.60	.52	.45	300/M ft.
36	.75	.60	.52	.45	300/M ft.

Price list for Tinned Copper Overbraid

Wire Gage	Price/Ft. 25' Spool	Price/Ft. 50' Spool	Price/Ft. 100' Spool	Price/Ft. 200' Spool	Price/M Ft. 500' & Over*
14	$.65	$.52	$.45	$.39	$260/M ft.
16	.62	.50	.44	.37	250/M ft.
20	.40	.32	.28	.24	160/M ft.
24	.27	.22	.19	.16	110/M ft.
30	.27	.22	.19	.16	110/M ft.
36	.27	.22	.19	.16	110/M ft.

*For quantities over 3,000 feet, please consult Sales Department for price.



Multipair Extension Cable*

The more common extension wire types are made up into standard multipair cables. Each conductor is covered with a polyvinyl jacket nominal 0.015″ (0.38 mm) thick and the pairs are individually twisted. Clear Mylar** tape is then wrapped around the bundle of twisted pairs. A solid 20-gage tinned-copper drain wire is laid over the bundle which is covered with an aluminum-backed Mylar tape serving as an electrostatic shield. The drain wire provides a simple mechanical termination for the shield. The cable is then covered with a jacket of polyvinyl approximately 0.045″ (1.1 mm) thick.

As an added convenience, each standard cable contains an extra polyvinyl-clad 22 AWG solid tinned-copper wire for use as a ground connection, or to complete a communication or signal circuit. Standard cables are color-coded. The individual pairs are marked 1-1, 2-2, etc., for easy identification. Insulation will withstand temperatures up to +221°F (+105°C).

Overbraiding

Any standard item can be overbraided with tinned copper, stainless steel or Inconel upon request.

Special Orders

Multipair extension cable can be made to order with insulation to suit your installation requirements. Consult Sales Department on pricing and quantity minimums.

Multipair Pricing

Multipair may be purchased in any quantity. Prices quoted per one thousand feet (M ft.) in tables.

To price out intermediate Quantities:

1-49 Ft.:

$$\frac{\text{50 ft. spool price}}{50} \times \text{Quantity}$$

50-99 ft:

$$\text{50 ft. Spool price plus } \frac{\text{50 ft. Spool price}}{50} \times \text{Quantity in excess of 50 ft.}$$

100-499 ft.:

$$\text{100 ft. Spool price plus } \frac{\text{Price per M ft.}}{1000} \times \text{Quantity in excess of 100 ft.}$$

500 Ft. and up:

$$\frac{\text{Price per M ft.}}{1000} \times \text{Quantity}$$

Thermocouple extension cable
22-gage solid polyvinyl insulated tinned-copper signal wire.

Discount Schedule:

500 to 2,999 ft.	Net
3,000 to 4,999 ft.	10%
5,000 to 9,999 ft.	15%
10,000 ft. and over	20%

CHROMEL/ALUMEL—ANSI TYPE KX

ANSI Color Code: Positive Wire, Yellow; Negative Wire, Red; Overall, Yellow

CATALOG NUMBER	NO. OF PAIR (TWISTED)	AWG NO.	INSULATION EACH CONDUCTOR	INSULATION OVERALL	NOMINAL OVERALL SIZE	APPROX. SHIPPING WT. PER 1000 FT.	PRICE FOR 50 FT.	PRICE FOR 100 FT.	PRICE PER M FT.
4KX20PP	4	20	Polyvinyl	Polyvinyl	0.390	83	**$ 95**	**$189**	**$1045**
8KX20PP	8	20	Polyvinyl	Polyvinyl	0.480	131	**155**	**309**	**2330**
12KX20PP	12	20	Polyvinyl	Polyvinyl	0.592	198	**215**	**429**	**2860**
16KX20PP*	16	20	Polyvinyl	Polyvinyl	0.653	245	**275**	**549**	**3660**
20KX20PP*	20	20	Polyvinyl	Polyvinyl	0.680	285	**331**	**662**	**4410**
24KX20PP*	24	20	Polyvinyl	Polyvinyl	0.770	338	**385**	**770**	**5130**

IRON/CONSTANTAN—ANSI TYPE JX

ANSI Color Code: Positive Wire, White; Negative Wire, Red; Overall, Black

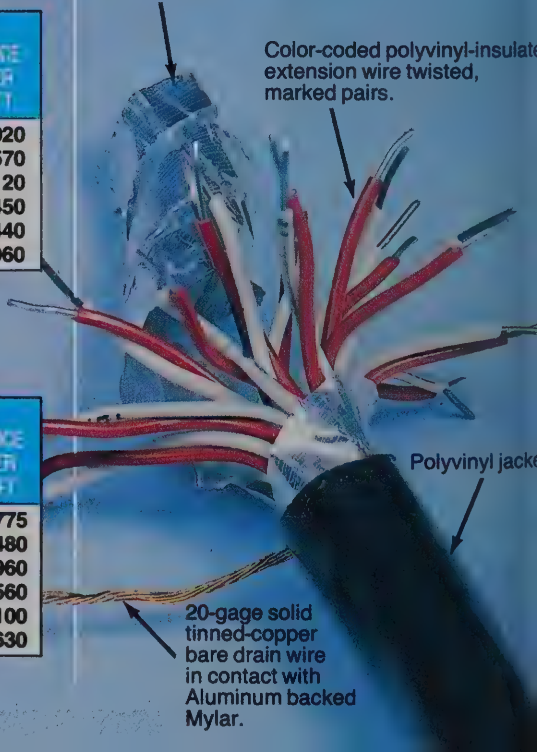
CATALOG NUMBER	NO. OF PAIR (TWISTED)	AWG NO.	INSULATION EACH CONDUCTOR	INSULATION OVERALL	NOMINAL OVERALL SIZE	APPROX. SHIPPING WT. PER 1000 FT.	PRICE FOR 50 FT.	PRICE FOR 100 FT.	PRICE PER M FT.
4JX20PP	4	20	Polyvinyl	Polyvinyl	0.390	83	**$ 69**	**$138**	**$ 920**
8JX20PP	8	20	Polyvinyl	Polyvinyl	0.480	131	**118**	**236**	**1570**
12JX20PP	12	20	Polyvinyl	Polyvinyl	0.592	198	**159**	**318**	**2120**
16JX20PP*	16	20	Polyvinyl	Polyvinyl	0.653	245	**184**	**368**	**2450**
20JX20PP*	20	20	Polyvinyl	Polyvinyl	0.680	285	**258**	**516**	**3440**
24JX20PP*	24	20	Polyvinyl	Polyvinyl	0.770	338	**372**	**744**	**4960**

COPPER/CONSTANTAN—ANSI TYPE TX

ANSI Color Code: Positive Wire, Blue; Negative Wire, Red; Overall, Blue

CATALOG NUMBER	NO. OF PAIR (TWISTED)	AWG NO.	INSULATION EACH CONDUCTOR	INSULATION OVERALL	NOMINAL OVERALL SIZE	APPROX. SHIPPING WT. PER 1000 FT.	PRICE FOR 50 FT.	PRICE FOR 100 FT.	PRICE PER M FT.
4TX20PP	4	20	Polyvinyl	Polyvinyl	0.390	83	**$ 75**	**$150**	**$ 775**
8TX20PP	8	20	Polyvinyl	Polyvinyl	0.480	131	**111**	**222**	**1480**
12TX20PP	12	20	Polyvinyl	Polyvinyl	0.592	198	**147**	**294**	**1960**
16TX20PP*	16	20	Polyvinyl	Polyvinyl	0.653	245	**198**	**395**	**2560**
20TX20PP*	20	20	Polyvinyl	Polyvinyl	0.680	285	**233**	**465**	**3100**
24TX20PP*	24	20	Polyvinyl	Polyvinyl	0.770	338	**273**	**545**	**3630**

*Consult Sales Department for delivery.


Aluminum-backed Mylar wrap
Color-coded polyvinyl-insulate extension wire twisted, marked pairs.
Polyvinyl jacke
20-gage solid tinned-copper bare drain wire in contact with Aluminum backed Mylar.

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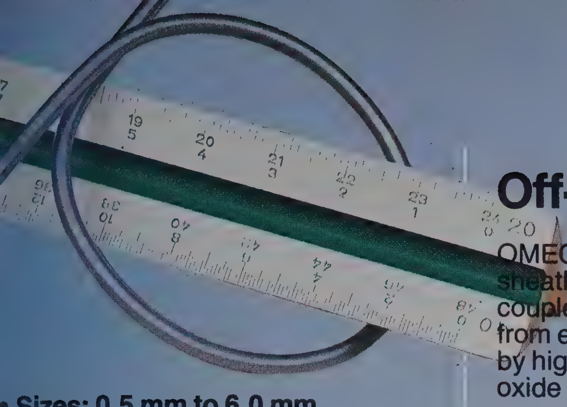
*UL approved as power limited tray cable to 221°F (105°C)

**Mylar is a trademark of DuPont Co.

Thermocouple Wire

OMEGACLAD™ Metric Sizes



- **Sizes: 0.5 mm to 6.0 mm**
- **Withstands High Temperatures and Pressures**
- **Weldable and Durable**
- **Bendable, Easily Formed**

Off-the-Shelf!

OMEGACLAD™ is a solid metal-sheathed cable containing thermocouple wires which are insulated from each other and from the sheath by highly compacted magnesium oxide (MgO).

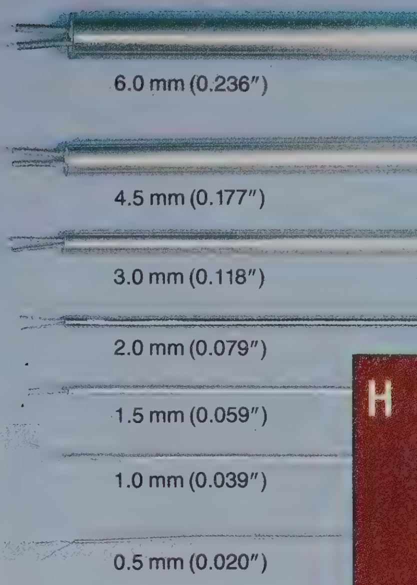
Metric size OMEGACLAD™ is available *off-the-shelf* in both 304 Stainless Steel and Inconel 600 sheathing. To order, follow the ordering example.

SINGLE PAIR METRIC OMEGACLAD

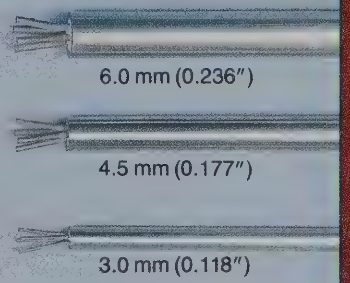
Catalog Number	Wire Calibration	Sheath Material	Sheath Diameter		Wall Thickness		Resistance 60°F Ohm/ dbl. ft.	Wire Diameter		Price/ Foot*
			mm	inches	mm	inches		mm	inches	
304-T-MO-0.5mm	Copper-Constantan T	304 Stainless Steel	0.5	0.020	0.076	0.003	20.85	0.089	0.0035	$ 3
304-T-MO-1.0mm			1.0	0.039	0.152	0.006	7.43	0.178	0.007	3
304-T-MO-1.5mm			1.5	0.059	0.254	0.010	3.03	0.254	0.010	3
304-T-MO-2.0mm			2.0	0.079	0.305	0.012	1.67	0.356	0.014	4
304-T-MO-3.0mm			3.0	0.118	0.457	0.018	0.77	0.559	0.022	5
304-T-MO-4.5mm			4.5	0.177	0.660	0.026	0.36	0.787	0.031	6
304-T-MO-6.0mm			6.0	0.236	0.940	0.037	0.20	1.016	0.040	7
INC-T-MO-0.5mm	Copper-Constantan T	Inconel 600	0.5	0.020	0.076	0.003	20.85	0.089	0.0035	$ 3
INC-T-MO-1.0mm			1.0	0.039	0.152	0.006	7.43	0.178	0.007	4
INC-T-MO-1.5mm			1.5	0.059	0.254	0.010	3.03	0.254	0.010	4
INC-T-MO-2.0mm			2.0	0.079	0.305	0.012	1.67	0.356	0.014	5
INC-T-MO-3.0mm			3.0	0.118	0.457	0.018	0.77	0.559	0.022	5
INC-T-MO-4.5mm			4.5	0.177	0.660	0.026	0.36	0.787	0.031	7
INC-T-MO-6.0mm			6.0	0.236	0.940	0.037	0.20	1.016	0.040	10
304-E-MO-0.5mm	Chromel-Constantan E	304 Stainless Steel	0.5	0.020	0.076	0.003	57.64	0.089	0.0035	$ 3
304-E-MO-1.0mm			1.0	0.039	0.152	0.006	14.53	0.178	0.007	3
304-E-MO-1.5mm			1.5	0.059	0.254	0.010	6.12	0.254	0.010	3
304-E-MO-2.0mm			2.0	0.079	0.305	0.012	3.54	0.356	0.014	4
304-E-MO-3.0mm			3.0	0.118	0.457	0.018	1.56	0.559	0.022	5
304-E-MO-4.5mm			4.5	0.177	0.660	0.026	0.92	0.787	0.031	6
304-E-MO-6.0mm			6.0	0.236	0.940	0.037	0.48	1.016	0.040	7
INC-E-MO-0.5mm	Chromel-Constantan E	Inconel 600	0.5	0.020	0.076	0.003	57.64	0.089	0.0035	$ 3
INC-E-MO-1.0mm			1.0	0.039	0.152	0.006	14.53	0.178	0.007	3
INC-E-MO-1.5mm			1.5	0.059	0.254	0.010	6.12	0.254	0.010	4
INC-E-MO-2.0mm			2.0	0.079	0.305	0.012	3.54	0.356	0.014	5
INC-E-MO-3.0mm			3.0	0.118	0.457	0.018	1.56	0.559	0.022	5
INC-E-MO-4.5mm			4.5	0.177	0.660	0.026	0.92	0.787	0.031	7
INC-E-MO-6.0mm			6.0	0.236	0.940	0.037	0.48	1.016	0.040	10
304-J-MO-0.5mm	Iron-Constantan J	304 Stainless Steel	0.5	0.020	0.076	0.003	29.64	0.089	0.0035	$ 3
304-J-MO-1.0mm			1.0	0.039	0.152	0.006	8.00	0.178	0.007	3
304-J-MO-1.5mm			1.5	0.059	0.254	0.010	3.81	0.254	0.010	3
304-J-MO-2.0mm			2.0	0.079	0.305	0.012	2.13	0.356	0.014	4
304-J-MO-3.0mm			3.0	0.118	0.457	0.018	1.38	0.559	0.022	5
304-J-MO-4.5mm			4.5	0.177	0.660	0.026	0.45	0.787	0.031	6
304-J-MO-6.0mm			6.0	0.236	0.940	0.037	0.25	1.016	0.040	7
INC-J-MO-0.5mm	Iron-Constantan J	Inconel 600	0.5	0.020	0.076	0.003	29.64	0.089	0.0035	$ 3
INC-J-MO-1.0mm			1.0	0.039	0.152	0.006	8.00	0.178	0.007	3
INC-J-MO-1.5mm			1.5	0.059	0.254	0.010	3.81	0.254	0.010	3
INC-J-MO-2.0mm			2.0	0.079	0.305	0.012	2.13	0.356	0.014	4
INC-J-MO-3.0mm			3.0	0.118	0.457	0.018	1.38	0.559	0.022	5
INC-J-MO-4.5mm			4.5	0.177	0.660	0.026	0.45	0.787	0.031	6
INC-J-MO-6.0mm			6.0	0.236	0.940	0.037	0.25	1.016	0.040	7
304-K-MO-0.5mm	Chromel-Alumel K	304 Stainless Steel	0.5	0.020	0.076	0.003	52.57	0.089	0.0035	$ 3
304-K-MO-1.0mm			1.0	0.039	0.152	0.006	13.23	0.178	0.007	3
304-K-MO-1.5mm			1.5	0.059	0.254	0.010	5.82	0.254	0.010	3
304-K-MO-2.0mm			2.0	0.079	0.305	0.012	3.28	0.356	0.014	4
304-K-MO-3.0mm			3.0	0.118	0.457	0.018	1.47	0.559	0.022	5
304-K-MO-4.5mm			4.5	0.177	0.660	0.026	0.66	0.787	0.031	6
304-K-MO-6.0mm			6.0	0.236	0.940	0.037	0.38	1.016	0.040	7
INC-K-MO-0.5mm	Chromel-Alumel K	Inconel 600	0.5	0.020	0.076	0.003	52.57	0.089	0.0035	$ 3
INC-K-MO-1.0mm			1.0	0.039	0.152	0.006	13.23	0.178	0.007	3
INC-K-MO-1.5mm			1.5	0.059	0.254	0.010	5.82	0.254	0.010	3
INC-K-MO-2.0mm			2.0	0.079	0.305	0.012	3.28	0.356	0.014	4
INC-K-MO-3.0mm			3.0	0.118	0.457	0.018	1.47	0.559	0.022	5
INC-K-MO-4.5mm			4.5	0.177	0.660	0.026	0.66	0.787	0.031	6
INC-K-MO-6.0mm			6.0	0.236	0.940	0.037	0.38	1.016	0.040	7

***Notes:** 1 inch = 25.4 mm, 1 mm = 0.0394 inches, 60°F = 15.6°C, 1 meter = 3.28 feet.

SINGLE PAIR



****DUAL PAIR**



**Dual Pair available on special request.

Ordering Example:

304-J-MO-1.5 mm-20 ft. specifies: a 20-ft. length of Type 304 Stainless steel sheath. 1.5 mm (0.059″) diameter, magnesium oxide insulated. OMEGACLAD™ with Type J thermocouple wires.

Minimum order: Five feet.

Custom Assemblies!

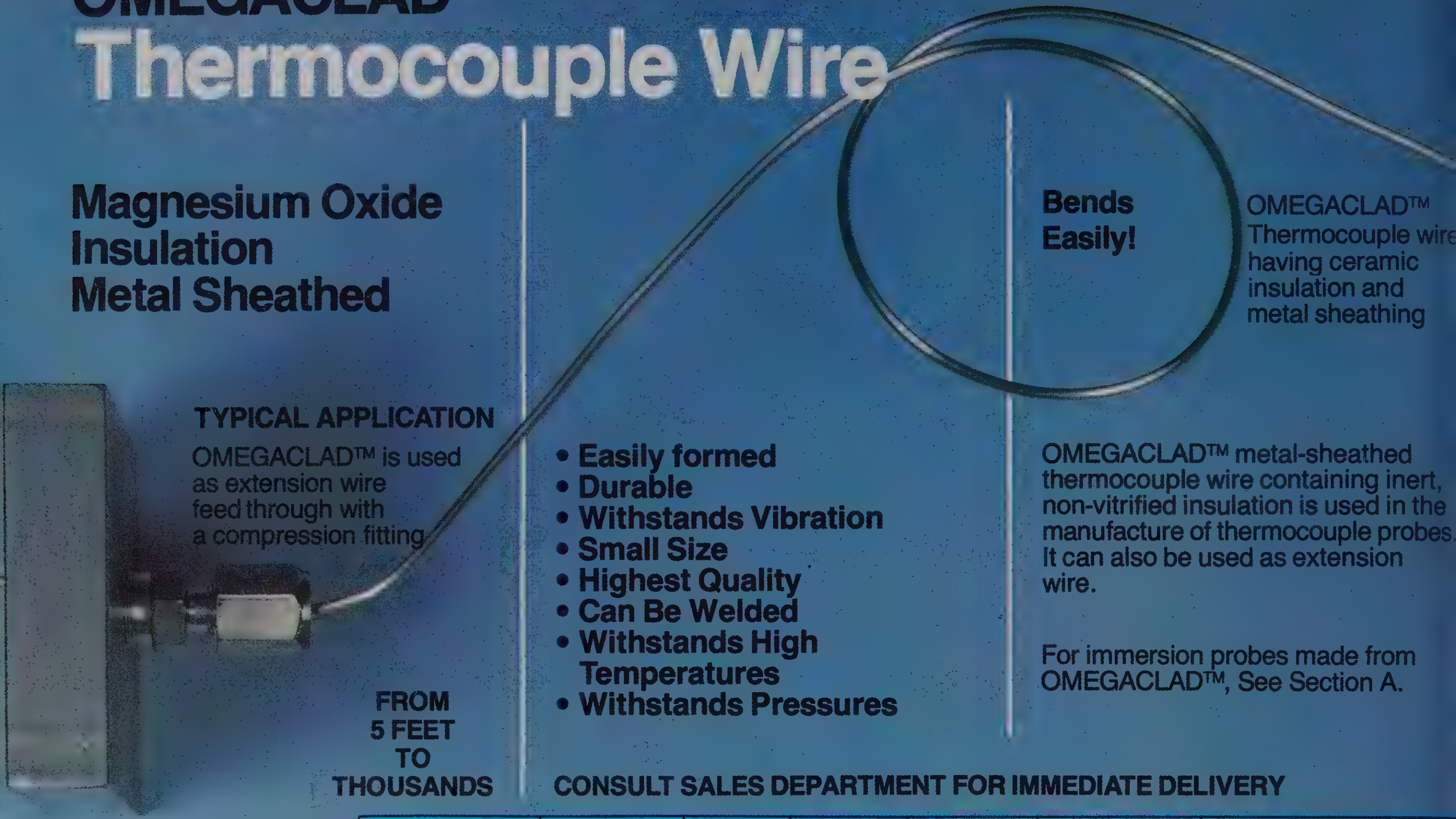
Special Sheathing, Insulation and Thermocouple Alloys are available on special order. Consult Sales Department for price and delivery.

Important Ordering Note: OMEGACLAD™ lengths will be supplied to ± 10% of specified length. Prices will be adjusted accordingly.

Discounts (per item): See schedule for English size OMEGACLAD™.

OMEGACLAD™ Thermocouple Wire

Magnesium Oxide Insulation Metal Sheathed



TYPICAL APPLICATION

OMEGACLAD™ is used as extension wire feed through with a compression fitting

Bends Easily!

OMEGACLAD™ Thermocouple wire having ceramic insulation and metal sheathing

- **Easily formed**
- **Durable**
- **Withstands Vibration**
- **Small Size**
- **Highest Quality**
- **Can Be Welded**
- **Withstands High Temperatures**
- **Withstands Pressures**

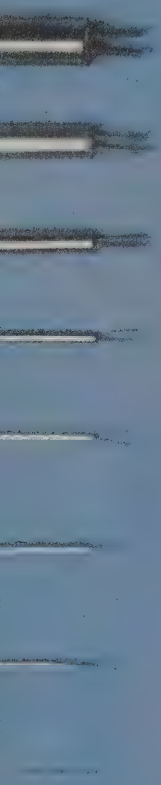
OMEGACLAD™ metal-sheathed thermocouple wire containing inert, non-vitrified insulation is used in the manufacture of thermocouple probes. It can also be used as extension wire.

For immersion probes made from OMEGACLAD™, See Section A.

FROM 5 FEET TO THOUSANDS

CONSULT SALES DEPARTMENT FOR IMMEDIATE DELIVERY

OFF-THE-SHELF IN THESE SIZES:



Catalog Number	Wire Calibration*	Sheath Material	Sheath Diameter (in.)	Wall Thickness (in.)	Resistance at 68°F Ohms/ Dbl. Ft.	Dia. of Wires (in.)	AWG Gage	Price/ Foot*
304-J-MO-010	Iron-Constantan J	304 Stainless Steel	0.010	0.0015	360	0.0015	50	$ 2
304-J-MO-020			0.020	0.003	23	0.004	38	1
304-J-MO-032			0.032	0.005	14.2	0.005	36	1
304-J-MO-040			0.040	0.007	8.9	0.006	34	1
304-J-MO-062			0.062	0.010	3.6	0.010	30	1.25
304-J-MO-125			0.125	0.018	0.88	0.020	24	1.50
304-J-MO-188			0.188	0.025	0.36	0.032	20	2.50
304-J-MO-250			0.250	0.036	0.22	0.040	18	4
INC-J-MO-010	Iron-Constantan J	Inconel 600	0.010	0.0015	360	0.0015	50	$ 2
INC-J-MO-020			0.020	0.003	23	0.004	38	1
INC-J-MO-032			0.032	0.005	14.2	0.005	36	1
INC-J-MO-040			0.040	0.007	8.9	0.006	34	1
INC-J-MO-062			0.062	0.010	3.6	0.010	30	1.25
INC-J-MO-125			0.125	0.018	0.88	0.020	24	2.50
INC-J-MO-188			0.188	0.025	0.36	0.032	20	3.50
INC-J-MO-250			0.250	0.036	0.22	0.040	18	6
304-K-MO-010	Chromel-Alumel K	304 Stainless Steel	0.010	0.0015	600	0.0015	50	$ 2
304-K-MO-020			0.020	0.003	38	0.004	38	1
304-K-MO-032			0.032	0.005	24.1	0.005	36	1
304-K-MO-040			0.040	0.007	15	0.006	34	1
304-K-MO-062			0.062	0.010	6.0	0.010	30	1.25
304-K-MO-125			0.125	0.018	1.5	0.020	24	1.50
304-K-MO-188			0.188	0.025	0.59	0.032	20	2.50
304-K-MO-250			0.250	0.036	0.37	0.040	18	4
INC-K-MO-010	Chromel-Alumel K	Inconel 600	0.010	0.0015	600	0.0015	50	$ 2
INC-K-MO-020			0.020	0.003	38	0.004	38	1
INC-K-MO-032			0.032	0.005	24.1	0.005	36	1
INC-K-MO-040			0.040	0.007	15	0.006	34	1
INC-K-MO-062			0.062	0.010	6.0	0.010	30	1.25
INC-K-MO-125			0.125	0.018	1.5	0.020	24	2.50
INC-K-MO-188			0.188	0.025	0.59	0.032	20	3.50
INC-K-MO-250			0.250	0.036	0.37	0.040	18	6

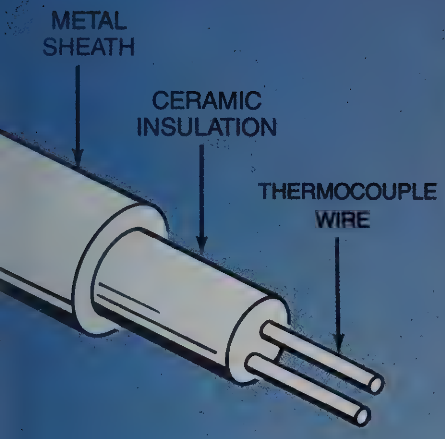
IMMEDIATE DELIVERY ON

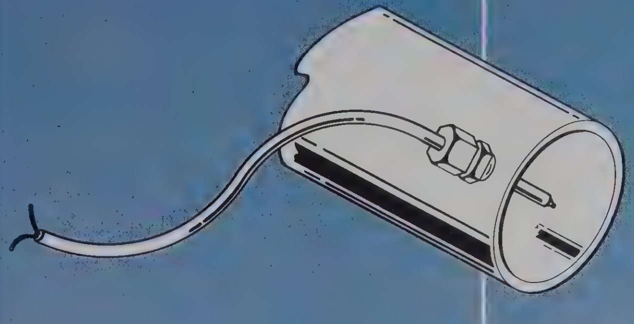
1. Chromel-Alumel
2. Chromel-Constantan
3. Iron-Constantan
4. Copper-Constantan

with

Magnesium Oxide Insulation
Inconel 600 and 304 SS sheathing

OMEGACLAD™
Thermocouple Wire





TYPICAL APPLICATION

OMEGACLAD™ is made into a grounded junction probe and inserted in pipe with compression fitting.

Ordering Example:

OMEGACLAD™ thermocouple wire is stocked for "off-the-shelf" delivery in Inconel 600 and type 304 stainless steel sheathing with magnesium oxide (MgO) insulation in the wire sizes and calibrations listed in the table below. Just add the desired length in feet to the catalog number as shown by the example: **304-J-MO-062-15**

Specifies: Type 304 Stainless Steel sheath, magnesium oxide insulation, Iron-Constantan thermocouple, 0.062″ (1.6 mm) diameter, 15 feet long. THIS IS OFF-THE-SHELF!

Other Sheaths, Insulation and Thermocouple Alloys Available

Thermocouples	Insulations	Sheaths
Platinum-Rhodium Alloys	Alumina	Tantalum 347SS
Tungsten-Rhenium Alloys	Beryllia	316SS 310SS

Catalog Number	Wire Calibration	Sheath Material	Sheath Diameter (in.)	Wall Thickness (in.)	Resistance at 60°F Ohms/ Dbl. Ft.	Dia. of Wires (in.)	AWG Gage	Price/ Foot*
304-T-MO-020	Copper-Constantan T	304 Stainless Steel	0.020	0.003	20	0.004	38	$ 1
304-T-MO-032			0.032	0.005	12.2	0.005	36	1
304-T-MO-040			0.040	0.005	7.7	0.006	34	1
304-T-MO-062			0.062	0.010	3.0	0.010	30	1.25
304-T-MO-125			0.125	0.018	0.75	0.020	24	2
304-T-MO-188			0.188	0.025	0.298	0.032	20	2.50
304-T-MO-250			0.250	0.036	0.19	0.040	18	4
INC-T-MO-020	Copper-Constantan T	Inconel 600	0.020	0.003	19.99	0.004	38	$ 1
INC-T-MO-032			0.032	0.005	12.2	0.005	36	1
INC-T-MO-040			0.040	0.007	7.66	0.006	34	1
INC-T-MO-062			0.062	0.010	3.04	0.010	30	1.50
INC-T-MO-125			0.125	0.018	0.75	0.020	24	3
INC-T-MO-188			0.188	0.025	0.19	0.032	20	4
INC-T-MO-250			0.250	0.036	0.19	0.040	18	6
304-E-MO-010	Chromel-Constantan E	304 Stainless Steel	0.010	0.0015	716.9	0.0015	50	$ 2
304-E-MO-020			0.020	0.003	45.41	0.004	38	1
304-E-MO-032			0.032	0.005	28.8	0.005	36	1
304-E-MO-040			0.040	0.007	18.09	0.006	34	1
304-E-MO-062			0.062	0.010	7.17	0.010	30	1.25
304-E-MO-125			0.125	0.018	1.78	0.020	24	2
304-E-MO-188			0.188	0.025	0.71	0.032	20	2.50
304-E-MO-250			0.250	0.036	0.45	0.040	18	4
INC-E-MO-010	Chromel-Constantan E	Inconel 600	0.010	0.0015	716.9	0.0015	50	$ 2
INC-E-MO-020			0.020	0.003	45.41	0.004	38	1
INC-E-MO-032			0.032	0.005	28.8	0.005	36	1
INC-E-MO-040			0.040	0.007	18.09	0.006	34	1
INC-E-MO-062			0.062	0.010	7.17	0.010	30	1.50
INC-E-MO-125			0.125	0.018	1.78	0.020	24	3
INC-E-MO-188			0.188	0.025	0.71	0.032	20	4
INC-E-MO-250			0.250	0.036	0.45	0.040	18	6

ALSO AVAILABLE IN FOUR WIRE CONSTRUCTION

CONSULT SALES DEPARTMENT

Stripping Tools Available. See page H-33.

Technical Notes:
Compacted magnesium oxide is hygroscopic (absorbs moisture).

Lengths: OMEGACLAD™ wire will be supplied to ± 10% of specified length. Prices will be adjusted accordingly. OMEGA cannot guarantee continuous lengths of OMEGACLAD™ 0.010″ (0.2 mm) diameter.

***Minimum Order:** 5 feet

Discount: (per item)

0-99 feet	list
100-249 feet	less 10%
250-499 feet	less 20%
500-999 feet	less 25%
Over 1,000 feet, Consult Sales Department	

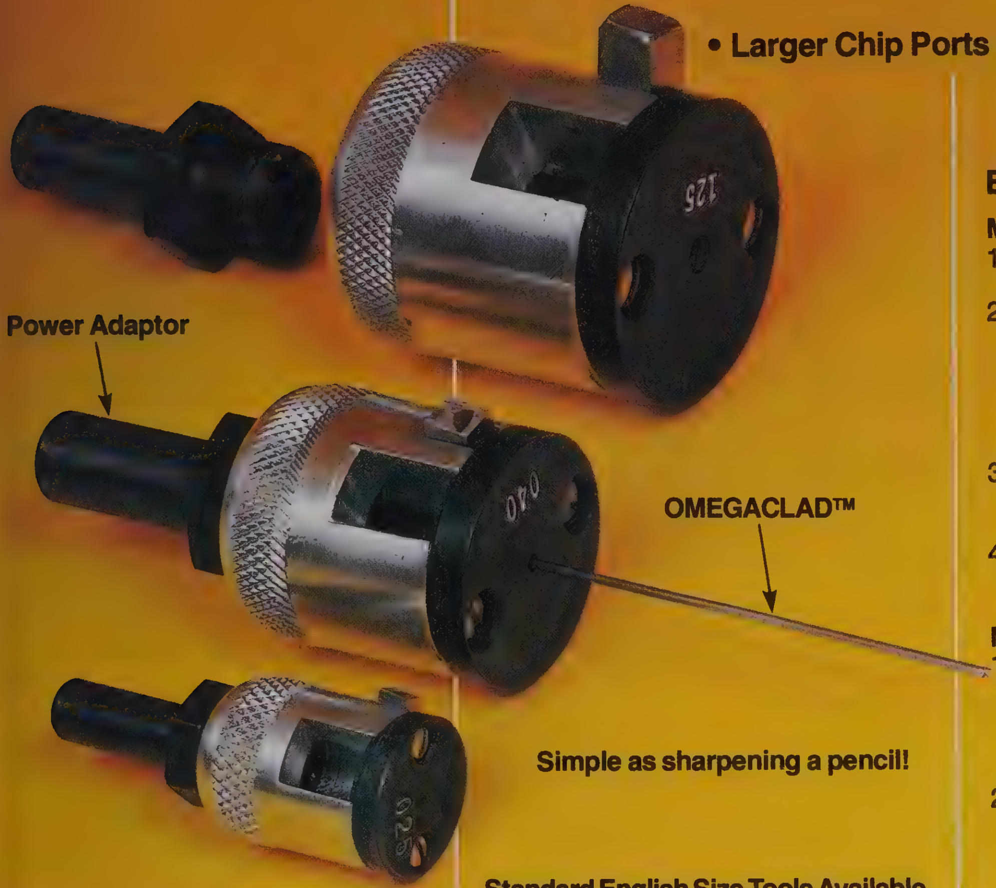
Maximum Temperature Ratings: 0.250″ type K—Inconel good to 2100°F (1148°C). 0.250″ type K—Stainless Steel good to 1650°F (898°C). 0.250″ type E—Stainless Steel or Inconel good to 1650°F (898°C).

STRIPPING TOOLS

For
Insulated
Single, Duplex
and
OMEGACLAD™ Wire

Thermocouple Wire Stripper

For Metal-Sheathed or Clad Wire



- **Larger Chip Ports for Continuous Self-cleaning**
- **Power Tool Adaptors**
- **Expanded Range of Sizes**

EASY-TO-USE

Method 1 (sizes 0.040″ and larger)

1. Secure the sheath in a vice, collet, or other holding fixture.
2. Locate the tool over the end of the sheath and apply a slight pressure on the tool while turning it by hand or machine rotating in a clockwise direction, as though sharpening a pencil.
3. After the cut has started, the tool will self-feed until it runs against the holding fixture.
4. Slip the tool off over the exposed wires.

Method 2 (sizes 0.032″ and smaller)

1. Firmly grip the sheath a small distance from the end (about ¼″) with a pair of flat jaw pliers or any other holder which will firmly grip without crushing the sheath.
2. Grab the adaptor by hand, feed the sheath into the opening and slowly rotate the stripper while applying slight pressure as though sharpening a pencil.
3. The tool will self-feed until it runs against the holding fixture.
4. Slip the tool off over the exposed wire.

Sheath Diameter vs. Rotational Speed

0.010 to 0.032″	hand
0.040 to 0.125″	hand to 300 rpm
0.185 to 0.250″	150 to 300 rpm

Where the stripping action is being conducted on semi-production or production quantities, the power adapted tool is recommended.

Standard English Size Tools Available

Nominal Sheath O.D.		Tool Tolerance	Part Number	Weight	List Price	
English	Metric				Hand	Power-Adapted
1/100″	0.25mm	0.095-0.0105″	ST010A	1 oz	*	$105
1/50″	0.5 mm	0.019-0.021″	ST020A	1 oz	*	71
1/40″	0.60mm	0.024-0.026″	ST025A	1 oz	*	71
1/32″	0.79mm	0.031-0.034″	ST032A	1 oz	*	71
1/25″	1.0 mm	0.040-0.044″	ST040	2½ oz	$61	66
1/16″	1.5 mm	0.060-0.064″	ST062	2½ oz	61	66
1/16″	1.57mm	0.063-0.067″	ST065	2½ oz	61	66
3/32″	2.38mm	0.090-0.094″	ST090	2½ oz	61	66
1/8″	3.17mm	0.122-0.128″	ST125	4½ oz	66	72
3/16″	4.75mm	0.185-0.190″	ST187A	8 oz	**	105
1/4″	6.25mm	0.247-0.253″	ST250A	8 oz	**	105

NEW! for Metric OMEGACLAD™ METRIC STRIPPERS

Nominal Sheath O.D.		Part Number	Weight	List Price	
Metric	English			Hand	Power-Adapted
0.5mm	0.02″	ST020A†	1 oz	*	$105
1.0mm	0.04″	ST040A†	2½ oz	$61	66
1.5mm	0.06″	ST062†	2½ oz	61	66
2.0mm	0.08″	ST20mm	2½ oz	61	66
3.0mm	0.12″	ST30mm	4½ oz	61	66
4.5mm	0.18″	ST45mm	8 oz	**	105
6.0mm	0.24″	ST60mm	8 oz	**	105

†English Equivalent

ORDERING INFORMATION:
Refer to charts for Catalog No. and prices.
Add "A" after part number to order power-adapted tools.
Extra tool bits and power adaptors also available.
Specify size. **$11 each.**

* Small diameter tools are supplied with the power adaptor to facilitate easy hand operation.

** Because of the torque required to operate tools larger than ⅛″ (3 mm), these tools are furnished with a power adaptor for machine rotation.

Wire Strippers

Hand Held Thermal

For Plastic and Rubber Covered Wire

Strips ALL Insulations ... TEFLON ... KEL-F ... NYLON ...
RUBBER ... NEOPRENE ... VINYL ... PLASTICS

- **Thermal wire stripping to highest industrial standards**
- **Long life, low-cost blades, easily replaced**
- **Ruggedly built for production use**
- **Self-contained ... hand held**
- **Can be used by inexperienced personnel**

Designed especially for electronic assembly to aerospace standards, the STRIPALL combines high production rates with consistently high wiring reliability. It is especially valuable when working with fine gage wire. Each unit has adjustable strip and wire-gage stops.

The rugged alloy blades have a long life under demanding production schedules. They heat to temperatures of 1700°F (926°C) in less than four seconds. They also cool instantly, eliminating the need for special racks or holding clips and providing complete operator safety.

Completely self-contained, the standard STRIPALL uses no external transformer or power supplies. The compact, solid state Temperature Control Unit supplied with some models is used to reduce blade temperature for certain insulation materials that burn, scorch or emit excessive fumes when contacted with the 1700°F (926°C) blade temperature of the standard STRIPALL.

Because of the unique gage stop, adjustable from #12 to #43 AWG, STRIPALL blades do not exert any pressure on the conductor itself. In addition to positively eliminating nicks or deformation, this feature also protects remaining insulation against damage, since the wire itself is not heated. The cut is clean and square, and no sleeving is melted into the wire strands. Insulation is easily cut at any predetermined point and the unwanted slug is quickly removed. Wire ends are ready instantly for soldering or other treatment.

STRIPALL*

Hand Held Thermal Wire Stripper

Prices start at **$108**

Stripall blades are long-lasting, low cost, easily replaced.

Ideal for Stripping Thermocouple Wire

*Tradename of Teledyne/Kinetics

Stripall

Hand Held Thermal Wire Strippers For Plastic and Rubber Covered Wire

Model TW-1: "Standard" Model
For general production work. Completely self-contained. Has adjustable stops for both wire gage and strip length.

Model TWC-1: Controlled Temperature
Has solid state temperature control. Temperature adjustable from 100°F (38°C) to above 1700°F (926°C). Solid state control mounts as electrical outlet, eliminating bench clutter. Blades reach selected temperature in less than 2 seconds.

Model TW-2 LN: Long Nose
Strips up to 3½″ in a single stripping action. Same operating features as the TW-1 except unit has four extra long electrodes. Can be used for stripping in inaccessible areas.

Model TW-3 LNS, Slim Nose
Unit has 3½″ long, narrow electrodes. Used for stripping wires in Computer Wells, Instrument Packages and other Enclosures. Narrow electrodes allow stripping in inaccessible areas.

Model TW-6, Cable Stripper
Designed especially for slitting and removing the outer coverings of cables. Removes Teflon , and KEL-F as well as low-temperature coaxial coverings. For coax cable or wire diameters ⅝″ (15.8 mm) or less.

Model TWC-6, Controlled Temperature
Same as TW-6, but including temperature control unit for adjustment from 100° F (38°C) to above 1700°F (926°C).

Note: *All models are available with a temperature control unit at $68 additional.*

ACCESSORIES

Model TBM Bench-Mounting Fixture
For holding any STRIPALL in fixed work position. STRIPALL may be removed from fixture when hand held operation is desired.

Replacement Blades
To order notched replacement blades for all two-blade models, add the prefix RBN to the model number.
Price: $4/pair.

Unnotched replacement blades for fine gage wire may be ordered by adding the prefix RVUN to the model number.
Price: $4/pair.

To order replacement blades for Models TW6 and TWC-6, add the prefix RBN-6 to the model number. **Price: $7/unit.** Example: RBN-6-TW6. Replacement blades for TW6.

OMEGA
TEMPERATURE CONTROL
MODEL TC-1
SER NO
ON
OFF
0
1
2
3
4
5
6
7
8
9
10

TW-1 $108

TWC-1 $165

TEMPERATURE CONTROL UNIT $68

TW-3 LNS $160

TW-2 LN $120

TW-6 $138

TWC-6 $185

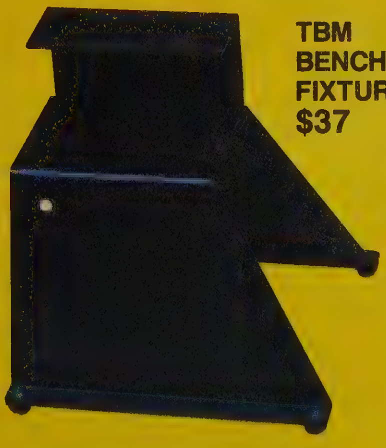
HIGH VOLTAGE STRIPALLS
All models are available for operation on 220 Volt ac, 50 Hz Line Voltage. Prices shown plus ten percent (10%).

Note:
Units are supplied with one notched blade to accommodate 32 AWG wire or larger. For smaller wire, order unnotched replacement blades.

Prices are subject to change.

Replacement parts are available for all units. Consult Sales Department for price and delivery.

Also Available:



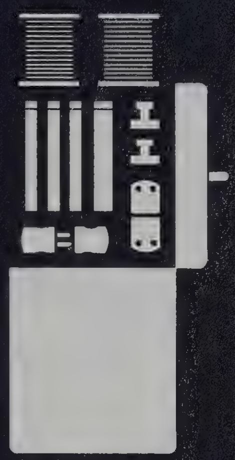
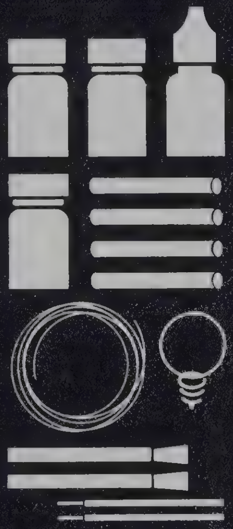
TBM BENCH FIXTURE $37

OMEGA CC HIGH TEMPERATURE CEMENT
LIQUID BINDER FOR OMEGA TEMPERATURE
OMEGA ENGINEERING, INC.
METAL
INSULATION
LENGTH
DATE
SIZE
Precision Fine Wire
PERATURE
ASUREMENT
N ENGINEERING
VOLUME 1 - Deals with thermocouple techniques for measuring temperatures

OMEGA
Precision Fine Wire Thermocouples
MANUAL ON THE USE OF THERMOCO
TEMPERAT
THERMCOAT
OMEGA CC HIGH TEMPERATURE CEMENT
ASTM STP

J

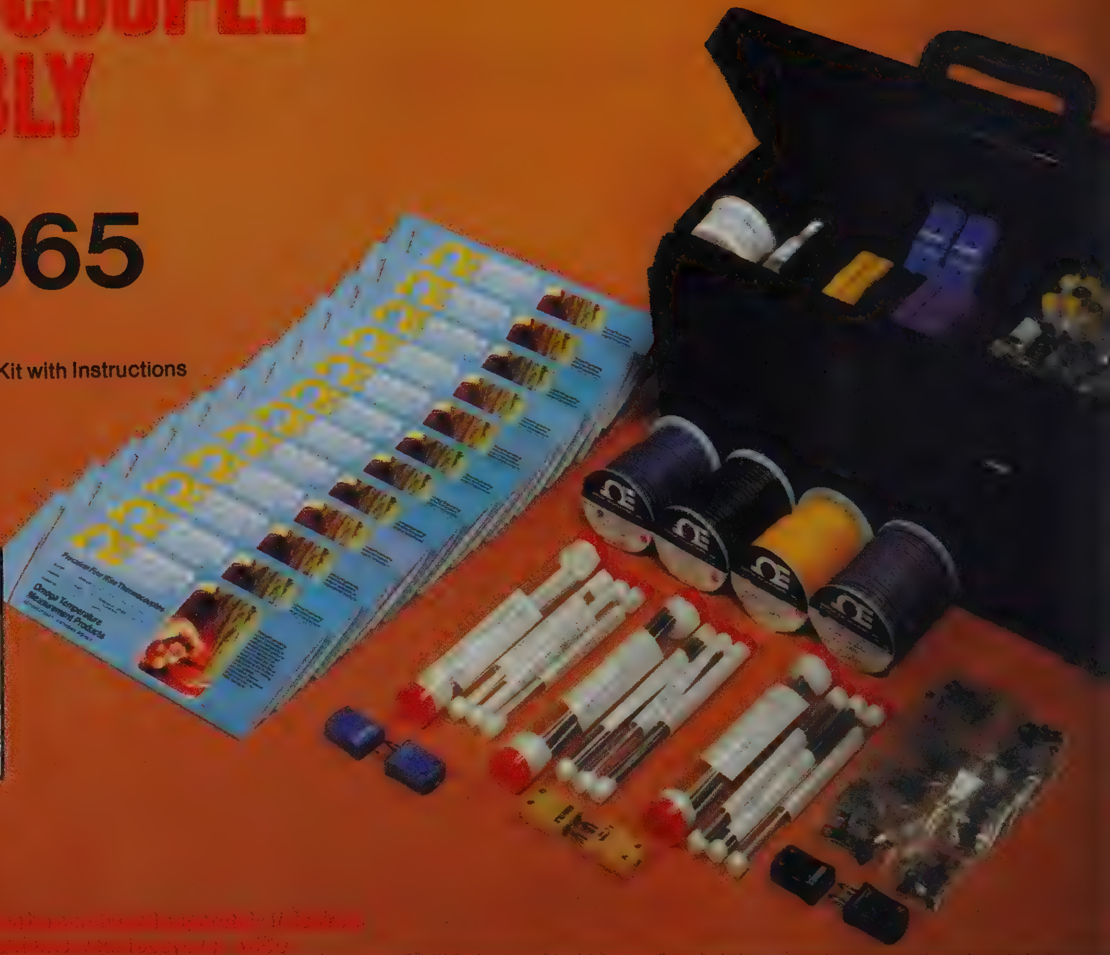
Cements, Coatings and Kits

Thermocouple Assembly Kit		J-3
Thermcoat Cement and Lacquer Kits		J-4
OMEGABOND™ Epoxies		J-5

THERMOCOUPLE ASSEMBLY

KIT N-965

$325 Complete Kit with Instructions



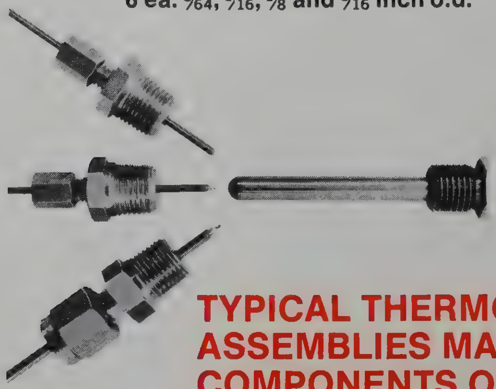
NOW AVAILABLE
At no extra charge the **OMEGA** 965 kit can be supplied in one or two thermocouple combinations instead of an assortment. Specify which combinations you desire.

[illegible]

CONTENTS

12 Color coded connectors (male and female)
  3 ea. Chromel-Alumel, Iron-Constantan, Copper-Constantan and Chromel-Constantan
12 Tube Clamps
  3 ea. 1/16, 1/8, 3/16 and 1/4 inch size
12 Cable Clamps
12 Compression Fittings
  3 ea. 1/16, 1/8, 3/16 and 1/4 inch size
8 Inconel, closed end tubes—6 inch length
  2 ea. 1/16, 1/8, 3/16 and 1/4 inch o.d.
8 Stainless Steel closed end tubes—6 inch length
  2 ea. 1/16, 1/8, 3/16 and 1/4 inch o.d.
4 Inconel open end tubes—6 inch length
  1 ea. 1/16, 1/8, 3/16 and 1/4 inch o.d.
4 Stainless Steel open end tubes—6 inch length
  1 ea. 1/16, 1/8, 3/16 and 1/4 inch o.d.
24 Two-hole insulating tubes—6 inch length
  6 ea. 3/64, 1/16, 1/8 and 3/16 inch o.d.
2 CC Cement (1 oz.)
60 Thermocouples—12 inch leads
  5 ea. Chromel-Alumel 0.005 in.
  5 ea. Chromel-Alumel 0.015 in.
  5 ea. Chromel-Alumel 0.032 in.
  5 ea. Iron-Constantan 0.005 in.
  5 ea. Iron-Constantan 0.015 in.
  5 ea. Iron-Constantan 0.032 in.
  5 ea. Copper-Constantan 0.005 in.
  5 ea. Copper-Constantan 0.015 in.
  5 ea. Copper-Constantan 0.032 in.
  5 ea. Chromel-Constantan 0.005 in.
  5 ea. Chromel-Constantan 0.015 in.
  5 ea. Chromel-Constantan 0.032 in.

25 feet Chromel-Alumel 20 AWG Extension wire
25 feet Chromel-Constantan 20 AWG Extension wire
25 feet Copper-Constantan 20 AWG Extension wire
25 feet Iron-Constantan 20 AWG Extension wire



TYPICAL THERMOCOUPLE ASSEMBLIES MADE FROM COMPONENTS OF KIT

IMMEDIATE DELIVERY

With the **OMEGA** Kit, you can build a variety of thermocouple probes and assemblies IN ONLY MINUTES. The contents of th kit include all necessary components to construct thermocouple probes for cryogenic through high temperature servic With this kit, every laboratory has at its fingertips the right probe at the right time. Micro-miniature, standard, and heavy duty thermocouples can be built with this kit.

Thermcoat Cement & Lacquer Kit Prices

THERMCOAT
Copper Oxide C
Cure: See Bulletin
Temp. Range: Useful to
OMEGA ENGINEERING, INC., Box 404
THERMCOA
Heat-Curing, Silicone Ph
Cure: Air Dry 1 hr. at
Heat 1 hr. at 300
Temperature Range — 230 t
Contents Flam
OMEGA ENGINEERING, INC., Box 404
ERMCO
Oxide Liq
GA's Copper
See Bulleti
NG, INC., Bo
C.C.
POWDER
C. LIQUID

The contents of **OMEGA'S THERMCOAT KIT** are used for cementing fine-gage thermocouples in place on metal, plastic and ceramic surfaces and for assembling thermopiles, temperature probes and thermocouple bolometers.

The contents of OMEGA'S THERMCOAT KIT include:

1 THERMCOAT CO
(copper oxide cement)
2 THERMCOAT COL
(liquid for copper oxide cement)
3 THERMCOAT SL
(heat curing silicone lacquer)
4 CC CEMENT
(high temperature cement)
5 ASSORTED FINE-GAGE CERAMIC INSULATORS
6 ASSORTED FINE-GAGE TUBING
7 Brushes, corkscrew, and assorted sleeving

$27 Cement and Lacquer Kit

Replacement Cements and Lacquers

Description and Catalog Name	SIZE AND PRICE			
	Replacement Vial	1 oz.	2 oz.	4 oz.
THERMCOAT CO	$5	$6	$9	$12
THERMCOAT COL	$5	$6	$9	$12
THERMCOAT SL	$5	$6	$9	$12

THERMCOAT CO
This is a fast setting two part cement which should be worked at temperatures between 60°F and 80° F. Work with very small quantities. Once cement has set, it cannot be reworked. Cements mixed too thinly, resulting from an excess of liquid COL, may cause spurious voltaic emfs to be generated in fine-gage thermocouples. Before applying cement, thoroughly clean surface and thermocouples and remove all contamination. Shelf life in excess of 2½ yrs.

THERMCOAT SL is a heat-curing silicone lacquer used for insulating thermocouples and lead wires. It is useful from −230°F to +450°F.

Color	Dark brown
Nonvolatile Content, percent after 3 hrs at 135°C (275°F)	49.0
Specific Gravity at 25°C (77°F)	1.01
Viscosity at 25°C (77°F), centipoises	110
Flash Point, open cup, degrees	32°C (90°F)
Solvent	Xylene
Drying Time, hrs at 200°C (392°F)	2.5

As Cured — cured 6 hrs at 200 C°(382°F)

Dielectric Strength, 2″ electrodes, volts/mil	2000
Dissipation Factor at 25°C (77°F), 100 Hz	0.010
100 KHz	0.007
Dielectric Constant at 25°C (77°F), 100 Hz	3.10
100 KHz	2.98
Surface Resistivity, ohms	1×10^{14}
Volume Resistivity, ohm-cm	2×10^{14}
Weight Loss, of solvent-free varnish after 3 hrs/250°C (482°F), percent	6.4
Thermal Conductivity, cal/sec (cm)°C	0.35×10^{-3}
Moisture Vapor Transmission, g/m^2/day	4.6
Heat Endurance at 250°C (482°F)	
Flex Life, hours	690
Craze Life, hours	1960
Thermal Life (curved electrode method)	
hours at 300°C (572°F)	350
hours at 275°C (527°F)	1500
hours at 250°C (482°F)	4000

OMEGA CC HIGH TEMPERATURE CEMENT

It is a porcelain-like cement consisting of two parts: a powder filler and a liquid binder. Mix 3 parts filler to 1 part liquid by weight, or 2 parts filler to 1 part liquid by volume. Hardens with an internal chemical setting action with an initial set in approximately 30 minutes and a final complete set in 18 to 24 hours at ordinary temperatures. The set may be decreased to 30 to 60 minutes after application by baking up to 175°F. The sodium silicate cement will withstand temperatures up to 2000°F. It adheres to practically all surfaces which are clean and free of oil and grease.

Physical Properties

Color	Tan
Compressive Strength	3900 psi
Tensile Strength	425 psi
Absorption	10-12%
Shrinkage	0.50%
Dielectric Strength . . . ASTM D-149 —	
at 70°F	25.0 to 51.0 Volts/mil
at 750°F	12.5 to 25.0 Volts/mil
at 1475°F	up to 1.3 Volts/mil
Volume Resistivity . . . ASTM D-1829 —	
at 70°F	10^7 - 10^9 ohm-cm
at 750°F	10^4 - 10^6 ohm-cm
at 1475°F	10^2 - 10^3 ohm-cm
Dielectric Constant	5.0 - 7.0
Thermal Conductivity (K Factor) — at 500°F	3.41 (BTU-inch)/(sq ft-hr-°F)
Coefficient of Thermal Expansion	4.6×10^{-6} in/in/°F
Density	141 pcf
Maximum Service Temperature	1550°F

Price . . . $15 per Kit

NOTE: Also available in 8 oz Filler $36 and 8 oz Binder $36

High Temperature and High Thermally Conductive Epoxies

"OMEGABOND" epoxy and **"OMEGATHERM"** thermal conducting paste are a series of high temperature and high thermally conductive epoxies and silicone products. They are specially formulated for permanent and temporary bonding of thermocouples, thin film RTDs, thermistors and other temperature sensors, to most surfaces—metals, ceramics, glass, plastics, paper products.

"OMEGABOND" and OMEGATHERM" products are compounded and packaged for convenient, easy mixing and application. Each formulation exhibits important characteristics necessary for accurate, fast, reliable temperature measurement. These are — good adhesion and strength, high temperature rating, high thermal conduction, high electric insulation, thixotropic consistency, fast cure, and easy application.

To assist in selection, a summary of each product's properties is shown in the accompanying table.

To facilitate fast and accurate component measuring, mixing and application, "OMEGABOND" is offered in convenient 1/4, 1/2 and 2 ounce "Twin Pak" Kits.

"Twin Pak" packaging is supplied to ensure the user with accurate proportioning of resin and catalyst as well as to provide a clean, fast means of mixing. "Twin-Pak" is a flexible, transparent plastic pouch, separated into two isolated compartments by means of a removable external divider. In one compartment is the resin, the other the pre-measured catalyst. To use, remove the divider, mix the two components by kneading the pouch, then snip off a corner to dispense. Each "Twin-Pak" comes with an instruction sheet, enclosed in a clear, heat-sealed plastic envelope.

OMEGABOND 100 — a fast (8 to 12 minute setting time) room temperature, two-part epoxy. Recommended for easy temporary and permanent bonding of beaded wire and "cement-on" thermocouples. Adheres to metals, ceramics, epoxy laminates, glass, wood, concrete and many other materials — for temperature measurements up to 265°F. It is not recommended to those endeavoring to achieve the ultimate in precision and speed of response since this unfilled system has a relatively low thermal conductivity.

Temporary installation of beaded wire thermocouples can be achieved by using a very small amount of "OMEGABOND" 100 to tack the bead to the surface and packing "OMEGATHERM" 201 around the exposed surface to improve heat transfer. This clear syrup consistency — 100% solid adhesive, contains no solvents and has good strength and electrical insulation characteristics. Note! The working time after mixing the two part system at room temperature is only 6 to 8 minutes. "OMEGABOND" 100 is available in "Twin Pak" packs and one and two pound kits.

Multi-Purpose
OMEGABOND & OMEGATHERM Kit

This versatile kit is suggested as a convenient way to determine the best means to bond sensor before ordering in quantity. Each kit contains:

four — 1/4 oz. "Twin Paks" OMEGABOND 100
two — 1/2 oz. "Twin Paks" OMEGABOND 101
two — 1/2 oz. "Twin Paks" OMEGABOND 200
two — 1/2 oz. Jars. OMEGATHERM 201

When ordering, specify "MPK-1" **$30 per kit**

OMEGA ENGINEERING, INC.
An OMEGA Group Company
Stamford, Connecticut 06907
OMEGABOND 101
CATALYST
OMEGA ENGINEERING, INC.
An OMEGA Group Company
Stamford Connecticut 06907
OMEGABOND 101
RESIN
OMEGA ENGINEERING, INC.
An OMEGA Group Company
OMEGATHERM 201
2 OZ. JAR
OMEGA ENGINEERING, INC.
An OMEGA Group Company
OMEGATHERM 201
1/2 OZ. JAR

$30 per kit

OMEGABOND 101 — is a very versatile room-temperature cure, high thermally conductive, two-part epoxy adhesive designed specifically to permanently bond — "cement-on", and beaded wire thermocouples and other sensors to the widest variety of materials. Adheres to most metals, wood, ceramics, cements, paper products, and many plastics and rubbers. It is rated for continuous use to 275°F. This thixotropic, off-white paste will set-up in approximately four hours at room temperature with full cure in 24 hours. Cure may be accelerated by using moderate heat.

OMEGABOND 101 has excellent shear and tensile strength, high electrical insulation and excellent chemical and solvent resistance. It is supplied in convenient "Twin Pak" packs as well as one and two pound kits, and is easy to mix, apply and cure.

OMEGABOND 200 — is a black, high temperature, high thermally conductive, two-part epoxy system, which will bond sensors to most materials, including metals, glass, ceramics and most plastics. It is recommended for bonding of "cement-on" and beaded wire thermocouples for accuracy, and fast temperature measurement to 500°F. The epoxy system cures at elevated temperatures. Cure time is 8 hours at 250°F, 2 hours at 400°F. It has excellent strength, and electrical insulating characteristics. Its thixotropic paste consistency virtually ensures freedom from sag during cure when applied to vertical surfaces.

OMEGABOND 200 is mixed 100 parts resin to 10 parts catalyst by weight and is supplied in "Twin Paks" to ensure proper formulating. One and two pound kits are also available.

OMEGATHERM 201 — is a very high thermally conductive filled silicone paste, ideally suited for many temperature measurement applications. This thick, grey, smooth paste wets most surfaces and will not harden on long exposure to elevated temperatures. It is rated for continuous use between −40°F and +400°F.

OMEGATHERM 201 provides an excellent means of conducting heat and expanding the heat-path area from a surface to a temperature measurement sensor, thus increasing the speed of response and improving accuracy. Some applications are:

a) **Surface Measurement Probes** — dab a small amount on the surface and push the sensor into this area.

b) **Temporary bonding and encapsulating of temperature sensors** — simply dab OMEGATHERM 201 on to the surface or in the cavity, plant the sensor in the paste and tape to hold in place.

This highly versatile paste is supplied in ½ and 2 ounce jars as well as in one and two pound containers.

Typical Properties

Cat. No.	OB-100	OB-101	OB-200	OT-201
Material	Fast Set Epoxy Adhesive	Epoxy Adhesive	Epoxy Adhesive	Silicone Grease
Continuous Temperature	265°F (130°C)	275°F (135°C)	500°F (260°C)	400°F (205°C)
Cure	8-12 min. set Room Temp.	Room Temp.	Elevated Temp.	Not required
Adheres to Most*	M,C,PL,PA W	M,C,PL,PA W	M,C,PL,PA W	Wets most Surfaces
Thermal conductivity (k) (BTU) (in)/(hr) (ft^2) (°F)	Low	High 7.2	Very high 9.6	Extremely High 16
Electrical Insulation Volume Resistivity ohm — cm	High 10^{12}	Very High 10^{15}	Very High 10^{15}	Very High 10^{14}
Tensile Shear ½" overlap, PSI	2000	2200	2700	—
Flexure Strength PSI		12,000	17,000	
Coef. Thermal Expansion of in/in/°F	51×10^{-6}	20×10^{-6}	21×10^{-6}	

* M = Metals
C = Ceramics
PL = Plastics
PA = Paper Products
W = Woods

Above information, while determined by tests and evaluation, is offered as a general guide. Actual suitability for a particular purpose is to be determined by material user. This information is not to be taken as warranty for which we assume legal responsibility.

Kit size vs Material	Catalog No. & Price per kit			
	OB-100-□	**OB-101-□**	**OB-200-□**	**OT-201-□**
"A"	OB-100-1/4 **$3** one ¼ oz. Twin Pak	OB-101-1/2 **$3.50** one ½ oz. Twin Pak	OB-200-1/2 **$5** one ½ oz. Twin Pak	OT-201-1/2 **$5** one ½ oz. Jar
"B"	OB-100-1 **$10** four ¼ oz. Twin Pak	OB-101-2 **$7** one 2 oz. Twin Pak	OB-200-2 **$7** one 2 oz. Twin Pak	OT-201-2 **$7.50** one 2 oz. Jar
1 lb. Two Can Kit	OB-100-16 **$25**	OB-101-16 **$30**	OB-200-16 **$30**	OT-201-16 **$25**
Two 1 lb. Kits	OB-100-32 **$40**	OB-101-32 **$50**	OB-200-32 **$50**	OT-201-32 **$40**

OMEGA
OMEGABOND 100
¼ OZ. TWIN PAK
OMEGA
OMEGABOND 100
¼ OZ. TWIN PAK
OMEGA
OMEGABOND 101
2 OZ. TWIN PAK

2515°F
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°C
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CALIBRATE
OFF
TEST
COARSE
FINE
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OMEGA
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RCL
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EXT CJ
DEC
INC
OMEGA ENGINEERING
One Omega Drive
Stamford, CT 06907
(203) 322-1666
TO INSTRUMENT

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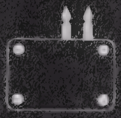
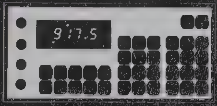
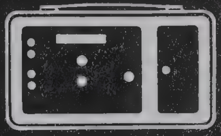
CL6503
06503
T1 T2 °C °F
PEAK BAT CAL mV HOLD
FAST
CAL
PEAK
HOLD
MEAS
OMEGA

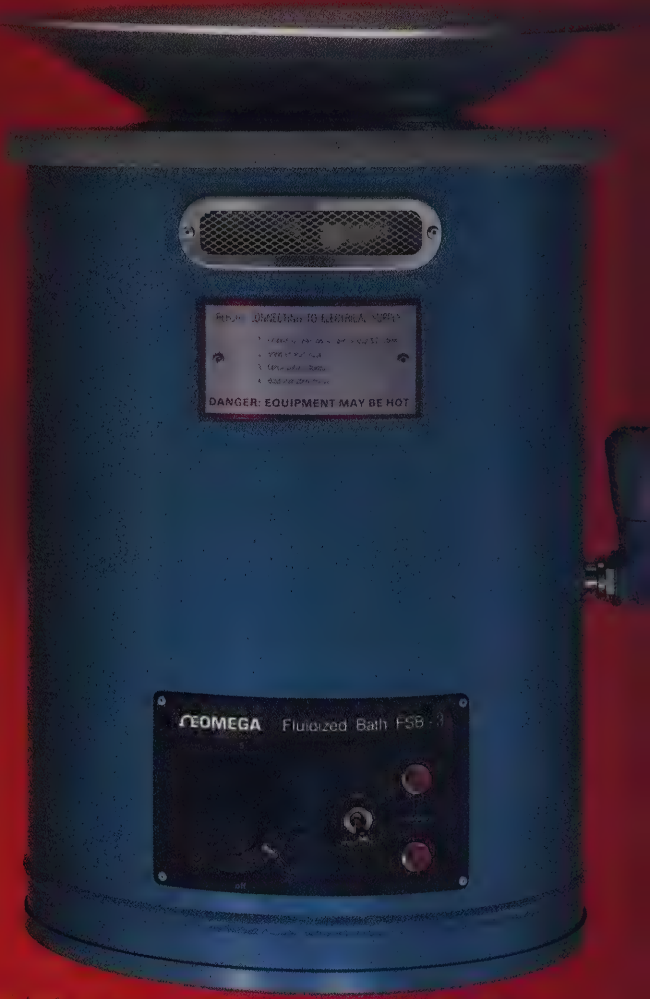
K

Precision Calibration Equipment and Ice Point References

NEW **FSB** **Fluidized Sand Baths**		K-3
TRC III **Ice Point Reference Chamber**		K-7
OMEGA-CJ/MCJ **Electronic Cold Junction Compensator**		K-10
OMEGA-LXCJ **Hermetically Sealed Cold Junction Compensator**		K-17
NEW **TAC-386** **Thermocouple to Analog Converter**		K-19
NEW **CL-505** **Precision Calibrator with Memory for 10 Calibration Points**		K-20
OMNI-CAL **Portable 4 and 8 Range Calibrators**		K-24
NEW **CL-466** **Digital Calibrator for Thermocouples, mV and mA Devices**		K-28
NEW **Series CL-6500** **Bench Top Microprocessor based Calibrator**		K-32
NEW **Series CL-300** **"Tool Box" Calibrators**		K-38

Fluidized Sand Baths—Choose the

DANGER: EQUIPMENT MAY BE HOT
OMEGA Fluidized Bath FSB-4


DANGER: EQUIPMENT MAY BE HOT
OMEGA Fluidized Bath FSB-3

FSB-4

$2825

FSB-3

$1995

- Two Temperature Ranges:
  122° to 662°F (50° to 350°C)
  122° to 1112°F (50° to 600°C)
- Safe, Clean, Dry Heat
- Burn-out Protection
- Stainless Steel Containers
- Inconel-sheathed Immersion Heaters
- Built-in Pressure Switch and Overload Fuse
- Rugged, Heavy-Duty, Accurate
- Spill Flanges Standard for all Models

Specifications

Temperature Stability ± 2°F (1°C)	Air Pressure 3 psi (20 kPa)
Temperature Uniformity 0.9°F (0.5°C)	Air Flow 2-4 cf/m (66 l/m)

Bath You Need

BEFORE CONNECTING TO ELECTRICAL SUPPLY:
DANGER: EQUIPMENT MAY BE HOT.
OMEGA Fluidized Bath FSB-2
high

BEFORE CONNECTING TO ELECTRICAL SUPPLY:
DANGER: EQUIPMENT MAY BE HOT
OMEGA Fluidized Bath FSB-1

FSB-1

$1050

FSB-2

$1325

e principle of fluidization occurs when a gas—
ually low pressure air or nitrogen—flows upward
rough a partially-filled chamber or retort of dry,
ert particles of aluminum oxide. The gas flows at
ow velocity which sets the particles in motion,
parates them, then suspends them to a stable
vel to give the particles an appearance of turbulence
quite similar to the state of boiling liquid.

esides circulating and flowing like a
uid, fluidized solids exhibit
cellent heat trans-
characteristics.
hen fluidized solids are heated, heat is distribut-
quickly and evenly throughout the bath and transferred
idly to objects submerged in the bath. The bath
mperature can be adjusted easily to the
int at which you wish to calibrate or
n a test.

Fluidized solids have no melting or boiling point. They will not solidify when the temperature drops, or emit vapors or odors at high temperatures. Solidification which takes place in cooling salt baths and fumes from hot oil baths are also eliminated. Fluidized solids are dry and relatively inert, making the medium safe and clean when compared to conventional liquid systems.

Fluidized baths for laboratory and instrument shop provide safe, rapid heat transfer and accurate temperature control, enabling you to efficiently and safely calibrate and maintain temperature sensitive instruments.

Fluidized Sand Baths

BEFORE CONNECTING TO ELECTRICAL SUPPLY.
DANGER: EQUIPMENT MAY BE HOT.
ΩOMEGA Fluidized Bath FSB-3

Ceramic tubes
not included

FSB-3

How to Operate

Just connect to an air line at 3 psi via ½ inch ID hose. (See filter and regulator on page K-6). Pour i the aluminum oxide supplied with the bath, turn o and you have a safe, clean, high temperature bath.

Air diffused through a ceramic or stainless steel porous plate at low pressure and low velocity converts the particulate medium into the fluidized state. The medium actually looks and feels like a bubbling liquid and provides excellent heat transfer and temperature uniformity.

Bath construction

The fluidized baths consist of a stainless steel inner container with a full diameter porous plate at the bottom. Inconel sheathed immersion heaters are located horizontally in the bath at a point just above the porous plate. The steel outer case is painted in heat resistant paint and is insulated from the inner container with 25 mm (1.0 in) thick fiberglass insulation.

The bath stands on three rubber feet and includes three wire cable and plug (117 V ac units only).

Air flow control

An air flow control valve is located on the side of the unit to accept low pressure air either from an air line or from a small air compressor, if a piped in source of air is not available.

Temperature setting and control

An energy regulator with graduations from 0 to 10 provides the means for setting the desired temperature. An external OMEGA sensor and thermometer are necessary if you want to measure the temperature level.

The temperature can also be controlled by using an OMEGA controller and probe.

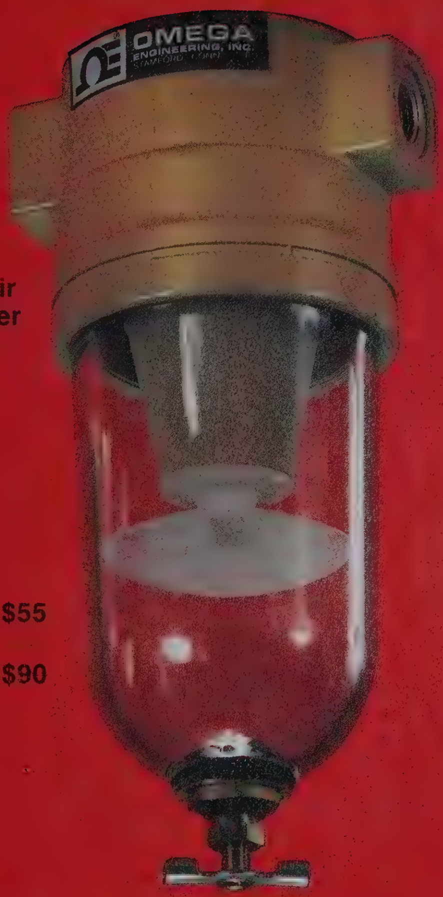
Heaters

In units with more than one heater, additional neon lights show the status of these switch-controlled heaters.

Each unit includes a built-in pressure switch operated by the fluidizing air. The switch automatically turns off all the heaters if fluidization is lost, thus protecting the heaters against burn out.

$1995

Accessories
For Series FSB



Air Filter

For providing uncontaminated air to the fluidized bath. This air filter is recommended for use with Pressure Regulator. Specify FSB-F-784.

$32

Replacement Sand

20 pounds Aluminum Oxide- FSB-A-20	$55
34 pounds Aluminum Oxide- FSB-A-34	$90

Pressure Regulator

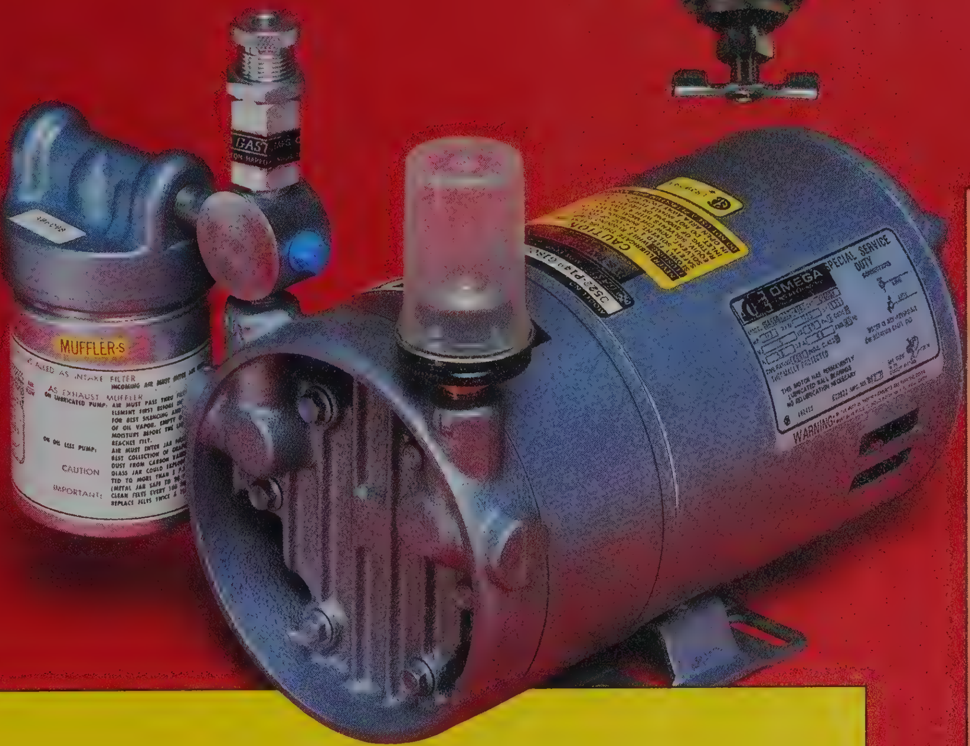
Reduces the pressure of air from air line to suit the fluidized bath. The Regulator is supplied with a pressure gauge reading from 0 to 30 lb/in^2. Specify FSB-P-783.

$44

Air Compressor

For those who do not have a convenient air line, this oil-less unit with self-lubricating carbon vanes provides the proper air supply to fluidize the laboratory units. Specify FSB-C-804.

$270



How to Order

Model No.	Price	Temperature Range	Working Volume dia × depth	Overall Volume dia × height	Power
FSB-1	**$1050**	122 to 662°F (50 to 350°C)	6.5″ × 4.5″ (165 × 114 mm)	9.5″ × 12″ (241 × 305 mm)	117* V ac (One 750 Watt Heater)
FSB-2	**1325**	122 to 662°F (50 to 350°C)	8.5″ × 5.5″ (216 × 140 mm)	11.5″ × 18.5″ (292 × 470 mm)	177* V ac (Two 1 kW Heaters)
FSB-3	**1995**	122 to 1112°F (50 to 600°C)	6.5″ × 7″ (165 × 178 mm)	13″ × 18″ (330 × 457 mm)	117* V ac (Two 750 Watt Heaters)
FSB-4	**2825**	122 to 1112°F (50 to 600°C)	8.5″ × 14″ (216 × 356 mm)	15″ × 26″ (367 × 660 mm)	240 V ac (Four 1 kW Heaters)

Also available with 240 V ac input power. Add 15% to price.

Ice Point Reference Chamber
High Precision

Model
TRC-III
State-of-the-Art Design

NEW *Dependability with Proven Quality*

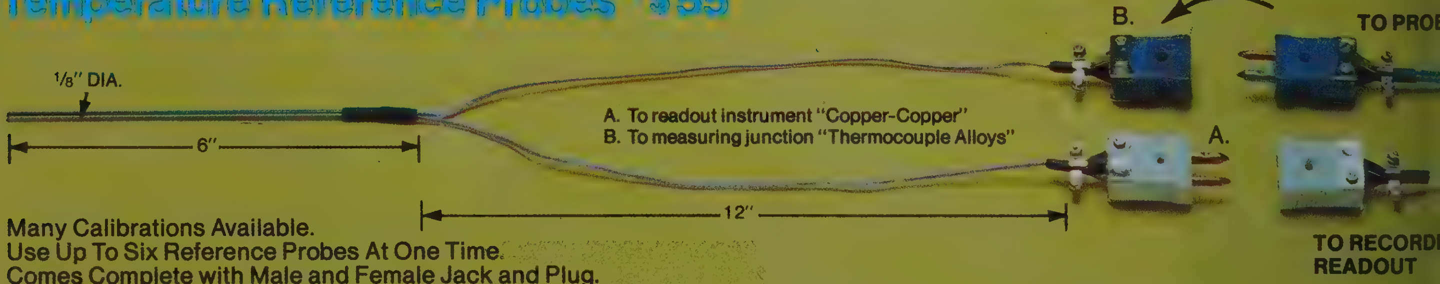
- A highly accurate 0°C thermoelectric "refrigerator"
- Eliminates old fashioned "ice bath"
- For *versatile* use in the factory, laboratory, instrument shop
  Calibration of all:
    - Temperature instruments
    - Temperature sensors
- Rugged Outercase for Safe Portability

$985

ON
Ice Point Cell

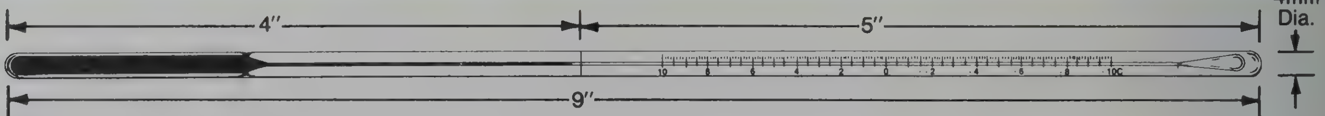
Also Available

Temperature Reference Probes *$55


1/8" DIA.
6"
A. To readout instrument "Copper-Copper"
B. To measuring junction "Thermocouple Alloys"
B.
A.
12"
TO PROB
TO RECORD
READOUT

Many Calibrations Available.
Use Up To Six Reference Probes At One Time.
Comes Complete with Male and Female Jack and Plug.
Can be supplied with 24" or 36" leads.

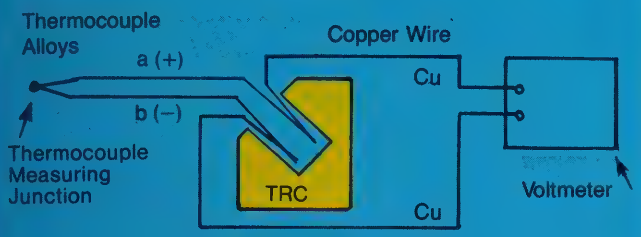
*Platinum probes, Tungsten probes **$130**



Model TRP-PT
Precision Thermometer $66
Used to check well temperature of your model TRC III ICE POINT

A very accurate Mercury in Glass Thermometer
- −10°C to +10° in 1/10 of 1° increments.
- 9 inches long
- 4 inch immersion length
- 4 mm diameter nominal and 4.2 mm maximum
- Certified Accuracy to ±1/4°C

Ice Point Reference



Accurate thermocouple temperature measurements require a stable reference junction. It is common practice to create a reference junction by transitioning both thermocouple legs to copper lead wire. When the transition reference junction is held at the ice point (0°C) the output of the thermocouple appearing across the copper leads leading to the readout instrument is stable and predictable. For accuracy and convenience, OMEGA offers its series TRP REFERENCE PROBE which locates the thermocouple-copper transition reference junction at the end of an 1/8″ diameter sheath for easy insertion into the TRC-III ice point calibration chamber. Up to six Series TRP Probes can be used at one time in OMEGA's Ice Point Chamber. Use the temperature-millivolt tables located in the technical section of this handbook to convert readings into °C or °F when using a voltmeter with the TRC-III.

Operating Principles:

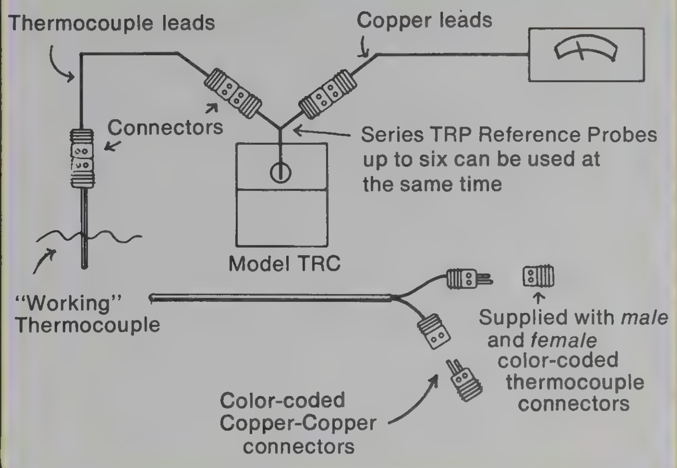
The OMEGA TRC Ice Point Thermocouple Reference Chamber relies on the equilibrium of ice and distilled, deionized water at atmospheric pressure to maintain six reference wells at precisely 0°C. The wells extend into a sealed cylindrical chamber containing the distilled, deionized water whose outer walls are cooled by thermoelectric cooling elements. The increase in volume produced by the creation of ice crystals within the cell is sensed by the expansion of a bellows which operates a microswitch and controls the cooling elements. The alternate freezing and thawing of the ice accurately maintains a 0°C environment around the reference wells.

Ease of Operation:

The automatic operational features of this instrument eliminate the need for frequent attention required of common ice baths. On-off cycling of pilot light indicates proper operation of unit at ice point temperature. Any combination of thermocouples may be used with this instrument by simply inserting the reference probes in the reference wells. Calibration of other types of temperature sensors at 0°C may also be performed.

For Accuracy:

When accurate temperature measurements are required, the OMEGA TRC III Ice Point Thermocouple Reference Chamber delivers that extra accuracy and precision you need. The reference wells are maintained at 0°C to within ±0.1°C and a stability of ±0.04°C for constant ambient. Continuous cycling operation maintains constant equilibrium conditions within the cell, eliminating the slow drift often experienced in common ice baths as melting proceeds.


Thermocouple leads
Copper leads
Connectors
Series TRP Reference Probes up to six can be used at the same time
Model TRC
"Working" Thermocouple
Supplied with *male* and *female* color-coded thermocouple connectors
Color-coded Copper-Copper connectors

How to Order:

Model TRC III Reference Chamber **$985**

TRP PROBES:

Catalog Designation	Thermocouple Type +	Thermocouple Type –	Price
TRP-K	Chromel	Alumel	$ 55
TRP-T	Copper	Constantan	55
TRP-E	Chromel	Constantan	55
TRP-J	Iron	Constantan	55
TRP-S	Plat. 10%	Pt.	130
TRP-R	Plat. 13%	Pt.	130
TRP-B	Plat. 30%	Plat. 6%	130
TRP-C	Tung. 5%	Tung. 26%	130
TRP-G	Tung.	Tung. 26%	130
TRP-D	Tung. 3%	Tung. 25%	130

Use up to six probes at one time with TRC-III.
Other alloys available. Write for prices.

Specifications:

Reference Wells:	Six wells, 5/32″ I.D., 3 3/4″ deep. Wells are thermally and electrically grounded to each other.
Reference Temperature:	0°C
Accuracy:	±0.1°C or better.
Stability:	±0.04°C for constant ambient.
"Environmental Ambient*":	35 to 90°F (2 to 32°C)
Power Required:	115/220V, 60Hz, 100 watts.
Stabilization Time:	Two to three hours depending on ambient temperature and thermal load.
Dimensions:	H: 12.0" (305 mm) x W: 6.25" (159 mm) x D: 12.7" (322 mm)
Weight:	21 lbs. (9.2 kg)

***Important Caution:** Unit must not be allowed to freeze or damage will result.

Thermocouple Reference Junction Principles

THEORY: When accurate thermocouple measurements are required, it is common practice to reference both legs to copper lead wire at the ice point so that copper leads may be connected to the emf readout instrument. This procedure avoids the generation of thermal emfs at the terminals of the readout instrument. Changes in reference junction temperature influence the output signal and practical instruments must be provided with a means to cancel this potential source of error. The EMF generated is dependent on a difference in temperature, so in order to make a measurement the reference must be known. This is shown schematically in Fig. #1 and can be accomplished by placing the reference junction in an ice water bath at a constant 0°C (32°F). Because ice baths are often inconvenient to maintain and not always practical, several alternate methods are often employed.

ELECTRICAL BRIDGE METHOD: This method usually employs a self-compensating electrical bridge network as shown in Figure 2. This system incorporates a temperature sensitive resistance element (R_T), which is in one leg of the bridge network and thermally integrated with the cold junction (T_2). The bridge is usually energized from a mercury battery or stable d.c. power source. The output voltage is proportional to the unbalance created between the pre-set equivalent reference temperature at (T_2) and the hot junction (T_1). In this system, the reference temperature of 0°C or 32°F may be chosen.

As the ambient temperature surrounding the cold junction (T_2) varies, a thermally generated voltage appears and produces an error in the output. However, an automatic equal and opposite voltage is introduced in series with the thermal error. This cancels the error and maintains the equivalent reference junction temperature over a wide ambient temperature range with a high degree of accuracy. By integrating copper leads with the cold junction, the thermocouple material itself is not connected to the output terminal of the measurement device, thereby eliminating secondary errors.

THERMOELECTRIC REFRIGERATION METHOD: The Omega TRC Thermoelectric Ice Point Reference Chamber relies on the actual equilibrium of ice and distilled, deionized water and atmospheric pressure to maintain several reference wells at precisely 0°C. The wells are extended into a sealed cylindrical chamber containing pure distilled, deionized water. The chamber outer walls are cooled by thermoelectric cooling elements to cause freezing of the water in the cell. The increase in volume produced by freezing an ice shell on the cell wall is sensed by the expansion of a bellows which operates a microswitch, de-energizing the cooling element. The alternate freezing and thawing of the ice shell accurately maintains a 0°C environment around the reference wells. An application schematic is shown in Fig. #3.

Completely automatic operation eliminates the need for frequent attention required of common ice baths. Thermocouple readings may be made directly from ice point reference tables, such as those listed in Section A, without making corrections for reference junction temperature. Any combination of thermocouples may be used with this instrument by simply inserting the reference junctions in the reference wells. Calibration of other type temperature sensors at 0°C may be performed as well.

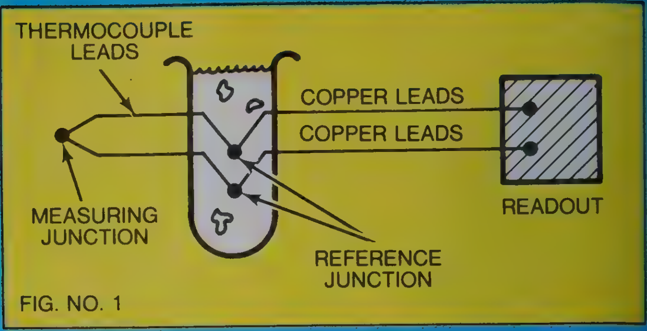


FIG. NO. 1

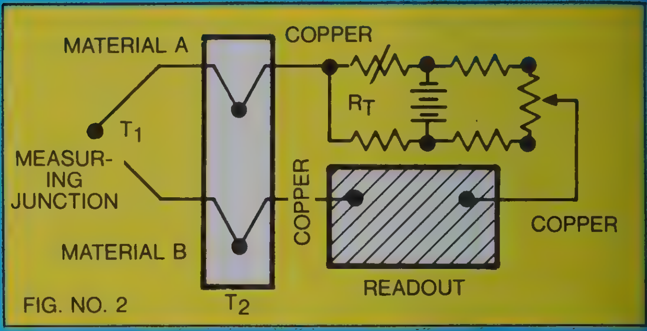


FIG. NO. 2

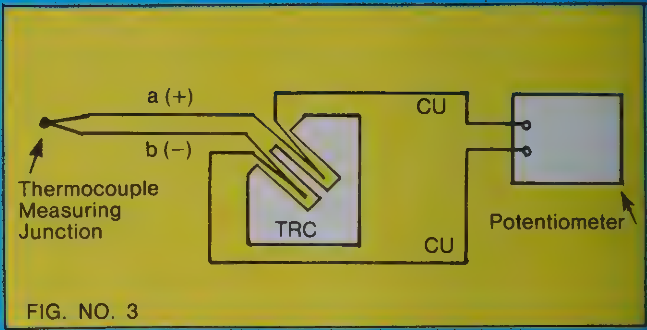


FIG. NO. 3

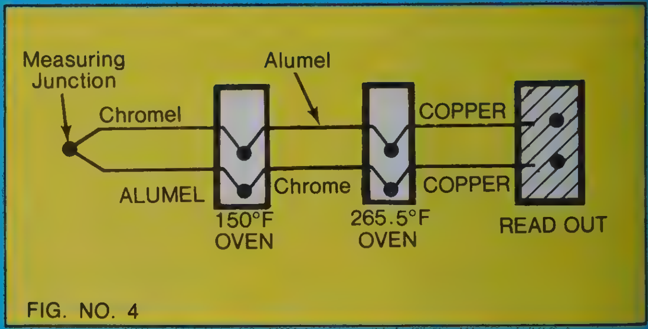


FIG. NO. 4

HEATED OVEN REFERENCES:
The double-oven type employs two temperature-controlled ovens to simulate ice-point reference temperatures as shown in Fig. 4. Two ovens are used at different temperatures to give the equivalent of a low reference temperature differing from the temperature of either oven. For example, leads from a Chromel-Alumel thermocouple probe are connected with a 150° oven to produce a Chromel-Alumel and an Alumel-Chromel junction at 150°F (2.66 mv each).

The voltage between the output wires of the first oven will be twice 2.66 mv or 5.32 mv. To compensate for this voltage level, the output leads (Chromel and Alumel) are connected to copper leads within a second oven maintained at 265.5°F. This is the precise temperature at which Chromel-Copper and Alumel-Copper produce a bucking voltage differential of 5.32 mv. Thus, this voltage cancels out the 5.32 mv differential from the first oven leaving 0 mv at the Copper output terminals. This is the voltage equivalent of 32°F (0°C).

6
7
8
9
T COPPER CONSTANTAN
CU/CU COPPER+ COPPER−
TO INSTRUMENT
OMEGA-CJ
cold junction compensator
OMEGA ENGINEERING
STAMFORD, CONN.
TO THERMOCOUPLE
T COPPER CONSTANTAN
OMEGA ENG INC
BOX 4047
STAMFORD, CT.
T COPPER CONSTANTAN +

Rugged
Metal
Case

hermocouple
old Junction
ompensator
MEGA-CJ

OMEGA CJ Compensators offer:
- High reliability
- Rugged construction
- Color coded thermocouple calibration
- Instantaneous warm-up
- Extreme versatility—Unit can be plugged directly into a thermocouple or into a jack panel
- Long battery life

OMEGA-CJ
Typical Applications

PERFORMANCE CHARACTERISTICS

EASILY REPLACED SELF-CONTAINED BATTERY ■ Omega-CJ provides ready access to replace used or questionable batteries. A standard battery clip permits pull-out snap-in change.

EXTENDED LIFE ■ A positive action "on-off" switch saves the battery when not in use. Has built-in Battery Test Indicator.

SIMPLE OPERATION ■ Plug unit into recorder banana jacks with universal adaptor. Plug thermocouple into other side of unit and throw "on-off" switch to "on" position. Readout is now converted to temperature readout referenced to zero degrees centigrade (0°C), and compensated for ambient temperature changes. Use *compensating extension wires* if thermocouple probe *is not* directly coupled to unit.

An internally adjustable balance (earlier models had control on outside) has been provided where extreme accuracy is required. Its purpose is to trim the reference level to 0°C. This simple adjustment is accomplished by allowing the OMEGA-CJ to stabilize in its ambient environment for approximately 15 minutes. The "BAL" control is adjusted until the readout registers the precise ambient with its input terminals shorted and its output connected to the readout device.

REFERENCE TEMPERATURE SETTING ■
0°C, standard

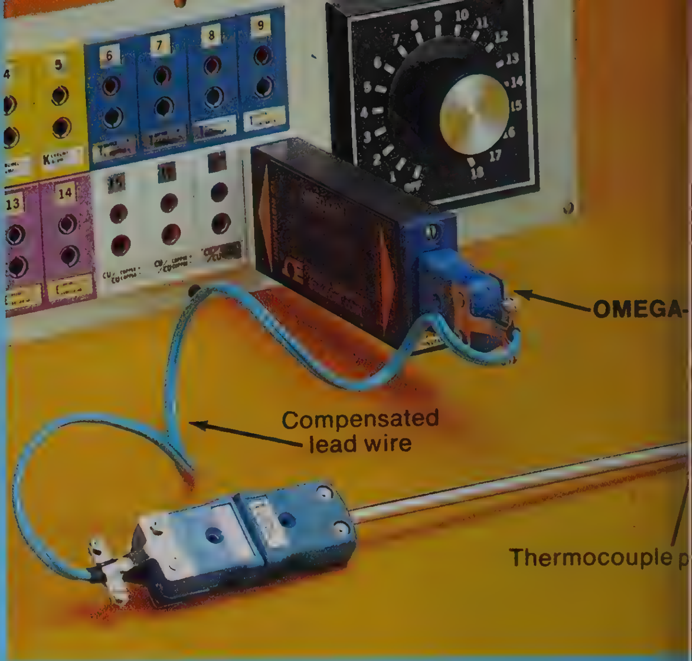
*** COMPENSATION ACCURACY** ■
±1/4°C, @ 25°C ambient setting
±1/2°C from 15°C to 35°C ambient
±3/4°C from 10°C to 50°C ambient

STORAGE TEMPERATURE ■
25°C to +75°C (without battery)

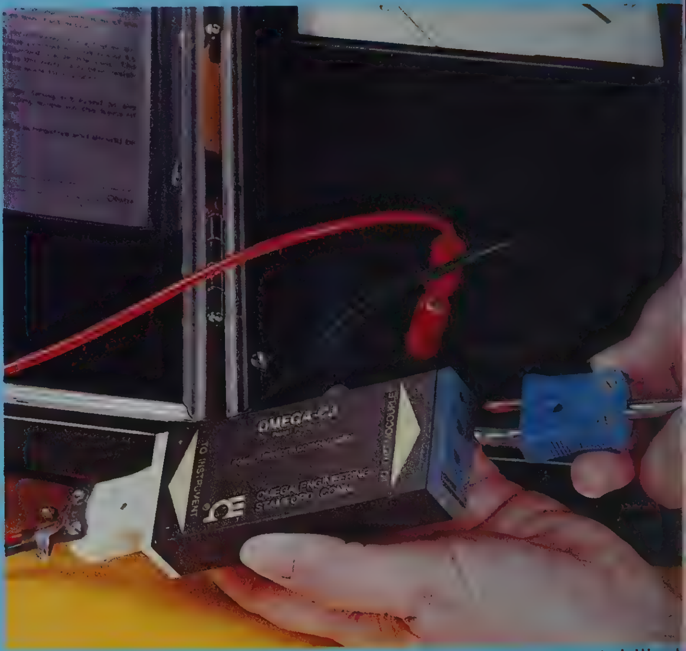
THERMOCOUPLE CALIBRATIONS ■
Compensation available for nine combinations as shown on Page K-12

OUTPUT IMPEDANCE ■ Less than 250 ohms, standard

*For standard reference temperature setting



Plugs into standard jack panel.

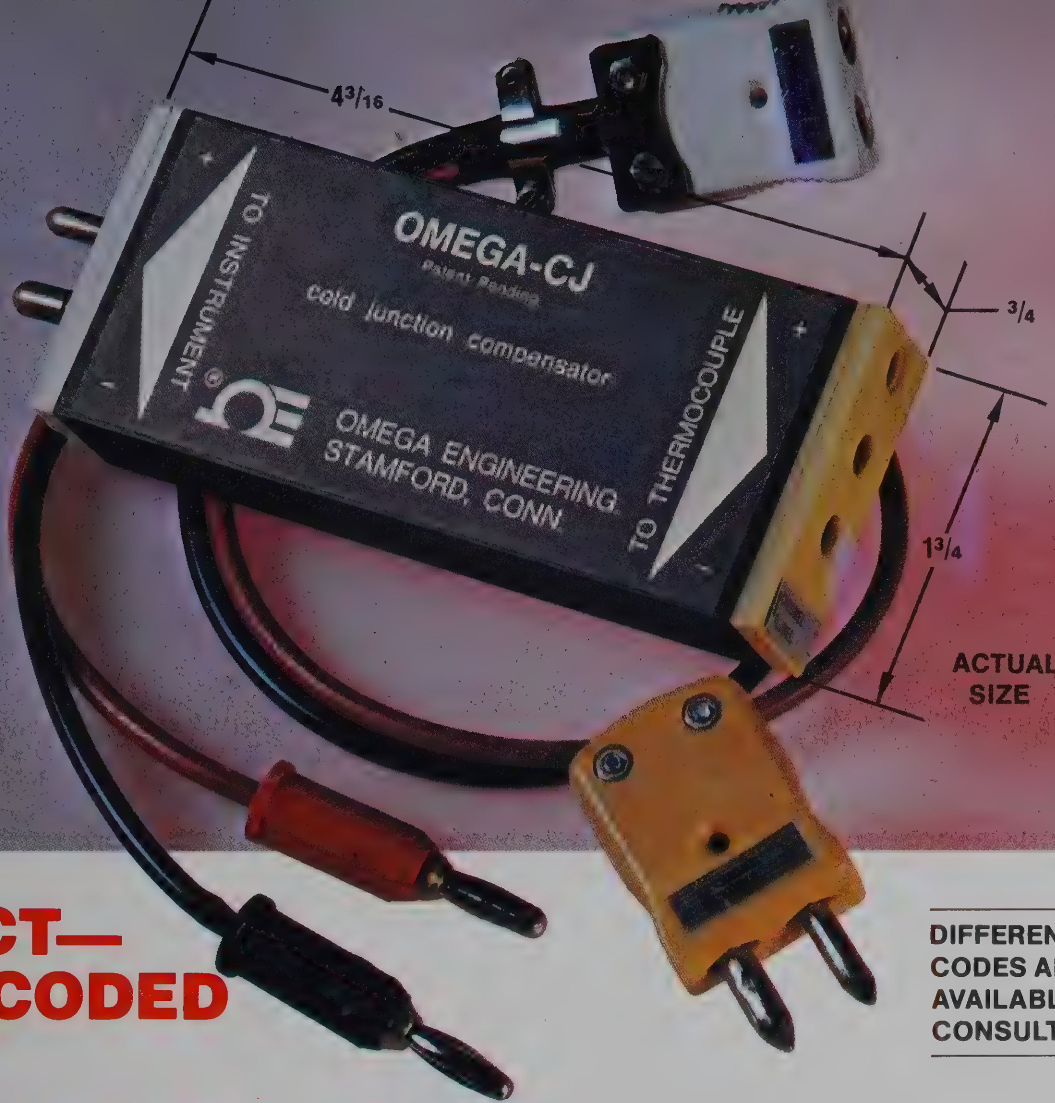


Plugs directly into readout meters for 0°C reference stabilizat

Use copper extension wire to potentiometer or readout device.
OMEGA CJ
Thermocouple prob

Extra batteries $3 each.

Thermocouple probe plugs directly into OMEGA
Signal to instrument is fully compensated to 0°



omes complete
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sconnect
ale plug,
nana jack
lapter and
ercury battery.

COMPACT— COLOR CODED

DIFFERENT COLOR
CODES ALSO
AVAILABLE!
CONSULT FACTORY

ALIBRATIONS AVAILABLE

- Chromel-Alumel
- Iron-Constantan
- Copper-Constantan
- Chromel-Constantan
- Pt/10% Rh-Pt
- Pt/13% Rh-Pt
- W-W/26% Re
- W/5% Re-W/26% Re
- W/3% Re-W/25% Re

FEATURES

Highly Reliable ■ Solid state circuitry with self contained battery.
Rugged ■ Sturdy aluminum case with heavy-duty construction.
Color Coded ■ Thermocouple calibration easily identified.
Instantaneous Warm-Up ■ Circuit components require no warm-up.
Miniaturization ■ Entire cold junction can plug into any standard panel board.
Highly Stable ■ Better than ±0.2°C at any stabilized temperature over its full +10°C to 50°C range.
Extremely Versatile ■ Unit can be plugged directly into a thermocouple or into a jack panel. Use adaptor jack and banana plugs that are provided to connect to meters, recorders or potentiometers.
Battery Life ■ 1500 hours or longer depending on calibration.
EXTRA BATTERIES $3 each, catalog #RM401R, 1.35 VDC.

Please note CJ's are available with reference junction temperatures other than 0°C; cost $165 each for calibrations K, J, T, E, S and R, $195 for calibrations G, C and D. Maximum reference temperature: 212°F.

aintains electrical equivalent of the Ice Point: 0°C or 32°F.

MODEL NO.	CJ-K	CJ-J	CJ-T	CJ-E	CJ-S	CJ-R	CJ-G*	CJ-C*	CJ-D*
Thermocouple Calibration –0°C	Chromel Alumel	Iron Constantan	Copper Constantan	Chromel Constantan	Pt/10% Rh Pt	Pt/13% Rh Pt	W W/26% Re	W/5% Re W/26% Re	W/3% Re W/25% Re
Color Coded	Yellow	Black	Blue	Violet	Green	Green	Red	Red	Red
Price	**$125**	**$125**	**$125**	**$125**	**$135**	**$135**	**$150**	**$135**	**$150**

Discount Schedule:

1-4 units	**Net**	**25-49 units**	**10%**
5-9 units	**5%**	**over 50 units consult factory**	
10-24 units	**7%**		

Electronic Ice Point . . .

NOW! Built into a Thermocouple Connector!

Features:

Highly Reliable:
Computer designed solid state circuit uses small "button" battery.

Rugged:
In sturdy connector housing.

Highly Stable:
Better than ±1°C at any stabilized temperature over its full ±10°C (50°F) to +45°C (113°F) range.

Miniaturization:
MCJ, including battery, weighs less than 2 oz. Dimensions: L: $2\frac{15}{16}$", W: 1", D: ½"

Convenient:
Compatible with any standard male or female thermocouple plug or jack. **JUST PLUG IT IN!**

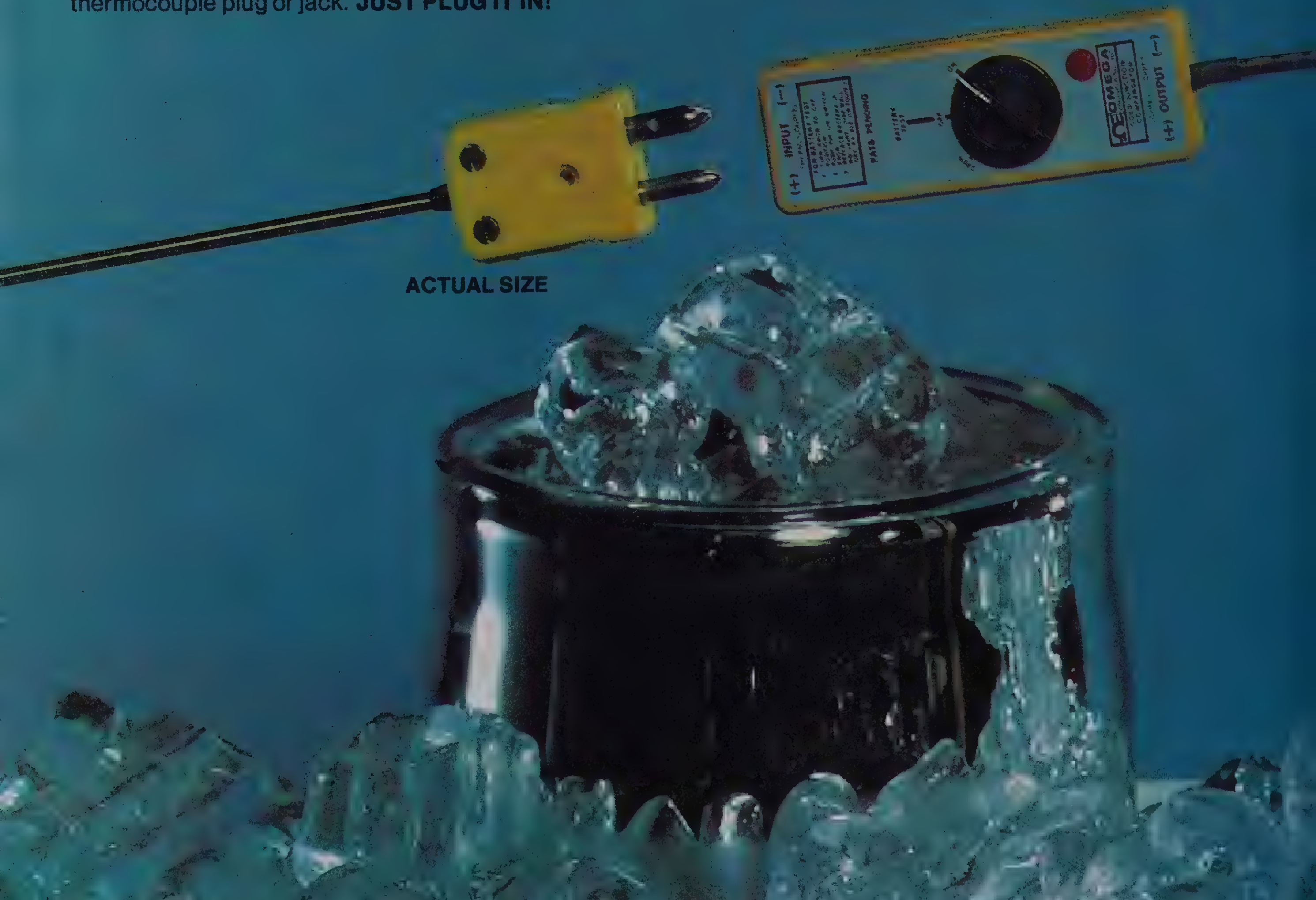
Low Battery Drain:
One small "button" battery (Type PX625, 1.35V) gives over 2500 hours continuous operation.

Extremely Versatile:
Can be plugged directly into a thermocouple or into a **jack panel.** Can be connected to meters, recorders and potentiometers. Uses ordinary copper extension wire from MCJ ice point to instrumentation.

Instantaneous Warm Up:
Circuit components require no warm up.

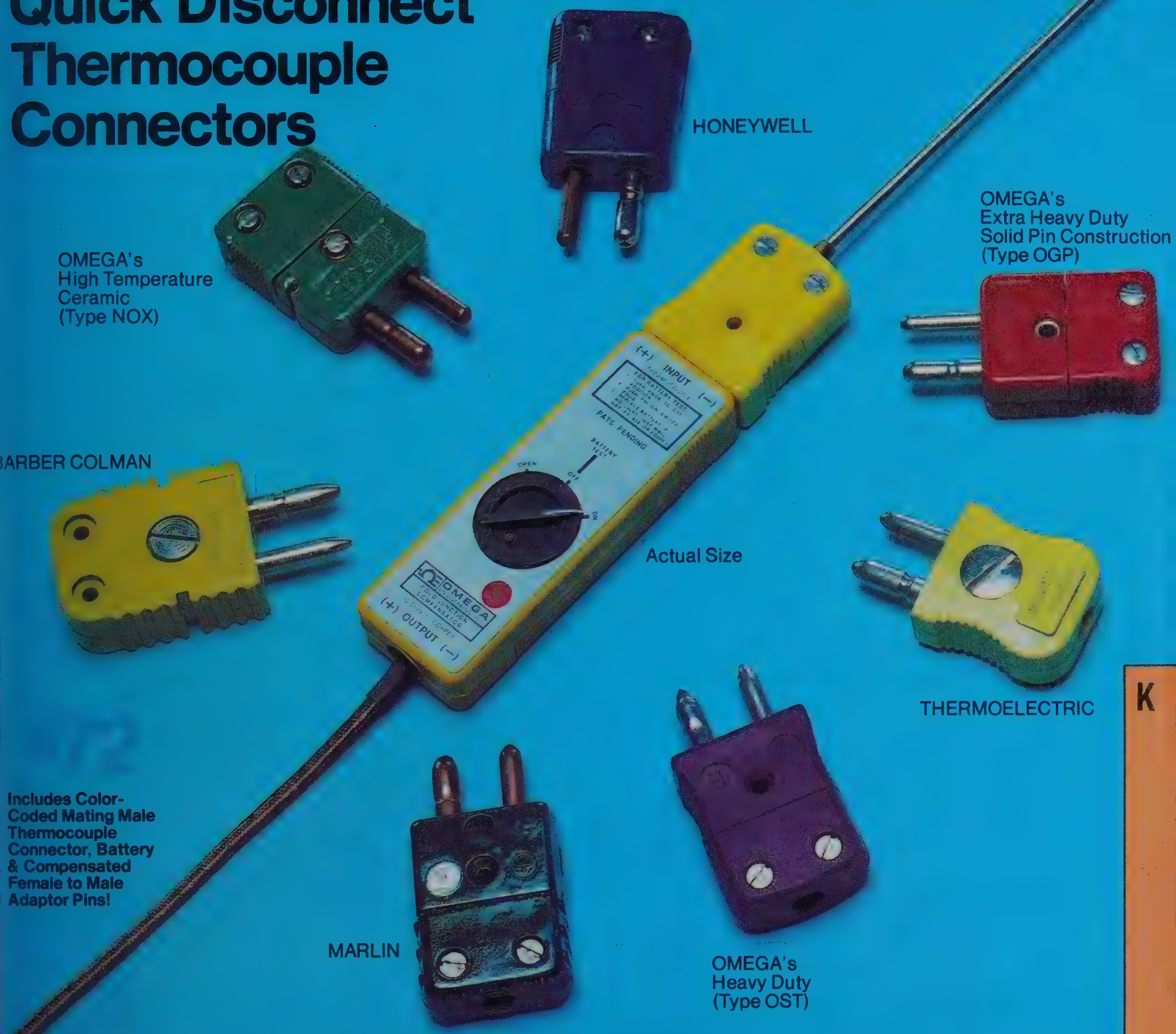
Use as Male Plug or Female Jack:
Set of positive and negative compensated male to female adaptor pins supplied allows for compensator to be used at the male or female junction.

Battery Check:
Simple built-in battery test indicator light.



ACTUAL SIZE

Compatible with Everybody's Standard Quick Disconnect Thermocouple Connectors


HONEYWELL
OMEGA's
Extra Heavy Duty
Solid Pin Construction
(Type OGP)
OMEGA's
High Temperature
Ceramic
(Type NOX)
(+) INPUT (−)
PATS PENDING
BATTERY TEST
OPEN
OFF
ON
OMEGA
(+) OUTPUT (−)
BARBER COLMAN
Actual Size
THERMOELECTRIC
MARLIN
OMEGA's
Heavy Duty
(Type OST)

Includes Color-Coded Mating Male Thermocouple Connector, Battery & Compensated Female to Male Adaptor Pins!

Original Concept

After 10 years of development OMEGA introduced the world's *most incredible Thermocouple Ice Point Reference* . . . built into a Thermocouple Connector!*

*Patents applied for

Discount Schedule:

1-4 units	Net	50-99	15%
5-9 units	5%	100-299	20%
10-24 units	7%	300-500	25%
25-49 units	10%	501 and up	30%

- All Connectors and OMEGA's Electronic Ice Point are shown actual size.
- The OMEGA MCJ Thermocouple Connector* has a built-in electronic, ice point reference system. It comes complete with compensated adaptor pins to convert it from a "female" to a "male" connector.
- OMEGA MCJ'S available in all nine important calibrations!

OMEGA MCJ

Performance Characteristics

Easily Replaced Self-Contained Battery
OMEGA MCJ provides ready access to replace used questionable batteries.

Battery Test
Has Built-in Battery Test Indicator

Converts from Female Jack to Male Plug
Compensated conversion pins supplied with unit.

Extended Life
Batteries will last 2500 hrs. in continuous operation.

Simple Operation
Connect Thermocouple to MCJ with any compatible male quick-disconnect, and to a readout device with standard copper leads.

The factory set balance provides a reference of 0°C (32°F) to an accuracy of one microvolt.

Reference Temperature Setting
0°C (32°F) standard.

Compensation Accuracy *
±1/2°C from 15°C (59°F) to 30°C (86°F) ambient
±1°C from 10°C (50°F) to 45°C (113°F) ambient

Storage Temperature
−25°C to +75°C (without battery)

Thermocouple Calibrations
Compensation available for nine standard calibrations.

Output Impedance
Less than 200 ohms standard

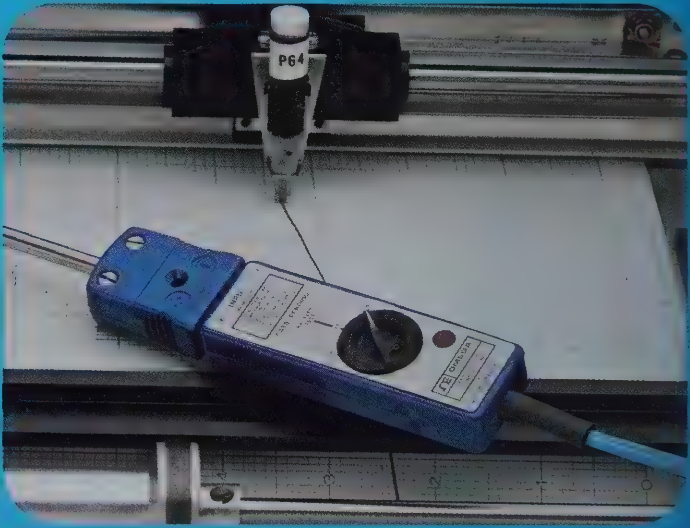
Extra Batteries $3 (Type Mallory PX625, 1.35 V)

*For standard reference temperature setting

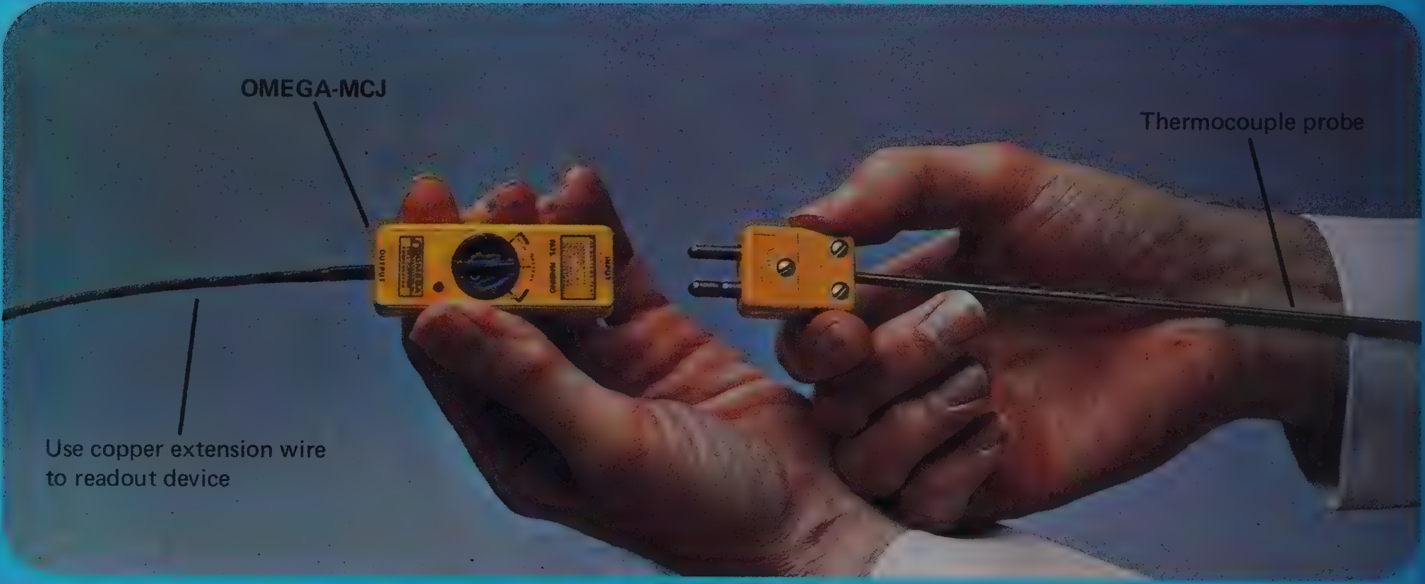
DIFFERENT COLOR CODES AVAILABLE!
CONSULT SALES DEPARTMENT

MULTIMETER

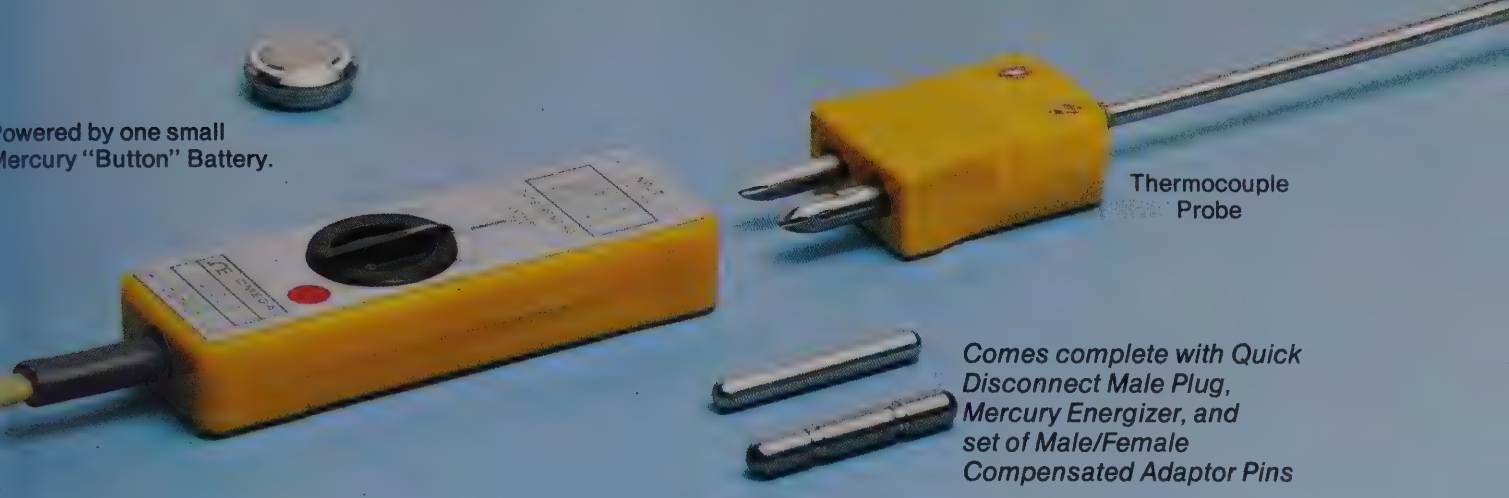
Thermocouple probe plugs directly into **OMEGA MCJ.** Signal to instrument is fully compensated to 0°C using **copper extension wires** from MCJ to instrument. Can be used to convert Digital Volt Meters for temperature (thermocouple) applications referenced to 0°C or 32°F.



OMEGA MCJ converts thermocouples into 0°C referenced voltages. Connects directly to mV recorders with copper wire. Convert recorded voltages using standard temperature—mV tables.



Thermocouple probe plugs directly into **OMEGA MCJ.** Signal to instrument is fully compensated to 0°C.



owered by one small
ercury "Button" Battery.

Thermocouple
Probe

Comes complete with Quick Disconnect Male Plug, Mercury Energizer, and set of Male/Female Compensated Adaptor Pins

To Recorder

MCJ-COMPACT COLOR-CODED

alibrations vailable

Chromel-Alumel (K)
Iron-Constantan (J)
Copper-Constantan (T)
Chromel-Constantan (E)
Pt-Pt/10% Rh(S)
Pt-Pt/13% Rh (R)
W-W/26% Re
W/5% Re-W/26% Re
W/3% Re-W/25% Re

DIFFERENT COLOR CODES ALSO AVAILABLE! CONSULT SALES DEPARTMENT

Model No.	Thermocouple Calibration	Color-Coded
MCJ-K	Chromel Alumel	Yellow
MCJ-J	Iron Constantan	Black
MCJ-T	Copper Constantan	Blue
MCJ-E	Chromel Constantan	Violet
MCJ-S	Pt Pt/10% Rh	Green
MCJ-R	Pt Pt/13% Rh	Green
MCJ-G*	W W/26% Re	Red/Green
MCJ-C*	W/5% Re W/26% Re	Red
MCJ-D*	W/3% Re W/25% Re	Red/White

*Not ANSI Symbol.

Design subject to change and improvement by OMEGA ENGINEERING, INC. as technological advances permit.

Features

- Connects directly to recorder
- Highly reliable
- Rugged
- Color-coded
- Miniaturization
- Highly stable
- Extremely versatile
- Low battery drain
- Instantaneous warm-up
- Battery test

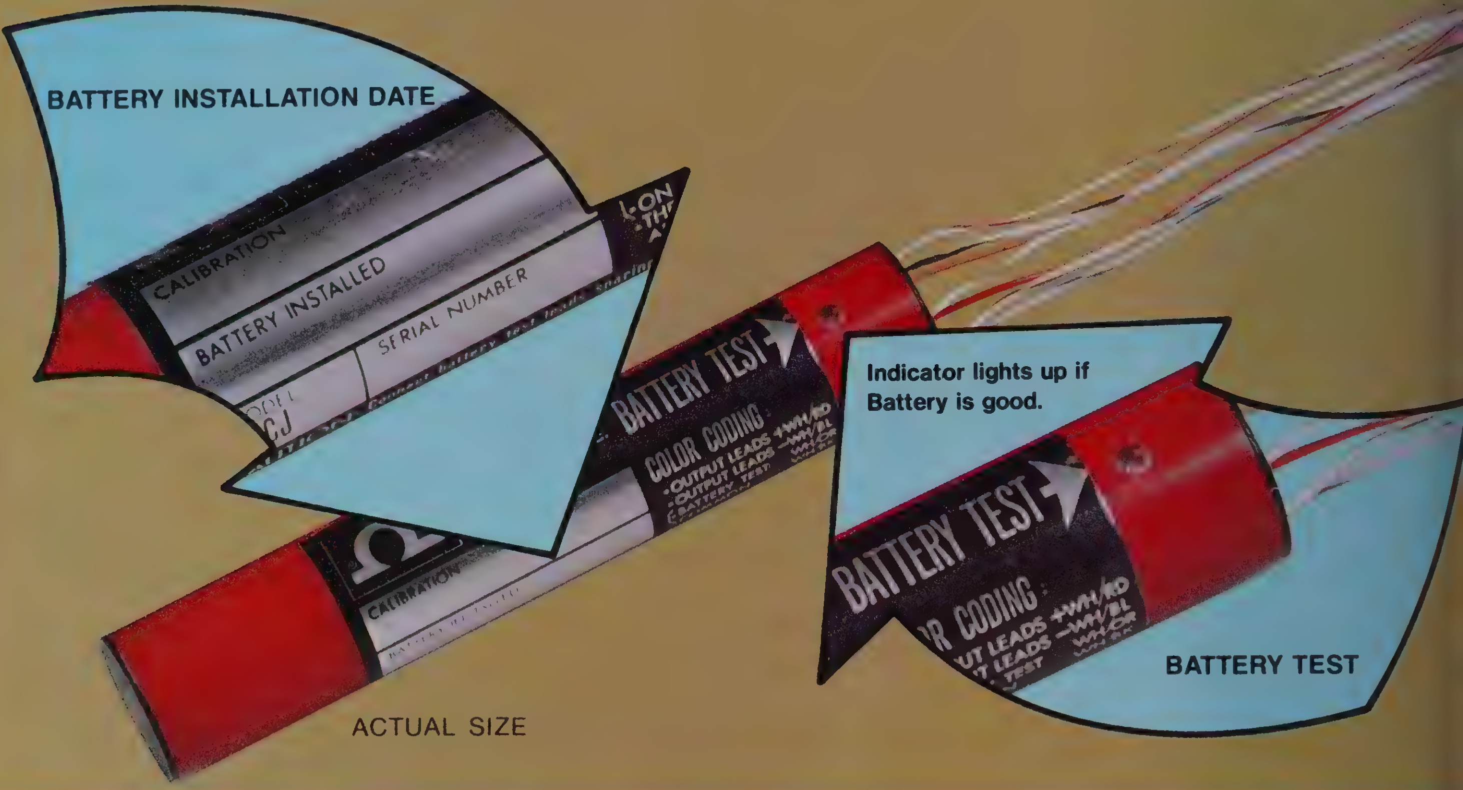
$72

Complete with male color-coded thermocouple plug, battery, male to female adaptor pins.

Available OFF-THE-SHELF"

SELF-POWERED THERMOCOUPLE REFERENCE JUNCTION

MODEL LXCJ–THE THERMOCOUPLE REFERENCE JUNCTION EXCLUSIVELY FROM OMEGA THAT PROVIDES "BUILT IN" ACCURATE BATTERY CHECK


BATTERY INSTALLATION DATE
CALIBRATION
BATTERY INSTALLED
SERIAL NUMBER
BATTERY TEST
COLOR CODING
Indicator lights up if Battery is good.
BATTERY TEST

ACTUAL SIZE

REPLACES ICE BATHS & OVENS • MINIATURIZED CIRCUITRY • HERMETICALLY SEALED • COLOR CODED

- **Completely Portable** Self-contained Mercury Battery
- **Fifteen (15) Calibrations Available**
- **Extreme Environmental Applications** Circuitry is completely epoxy encapsulated
- **Instantaneous Use** Joining of the external "Switch" leads provides immediate power for operation
- **Built-In Battery Test Indicator** Glows through window on side of unit
- **No Warm Up** Solid State circuitry is operational immediately
- **Long Life** 5,000 hours continuous use; 2 to 3 years intermittent use
- **To Assure Optimum Battery Life** Battery installed just prior to shipment, with installation date permanently recorded on unit

Patented

Self-Powered Thermocouple Reference Junction

How It Works

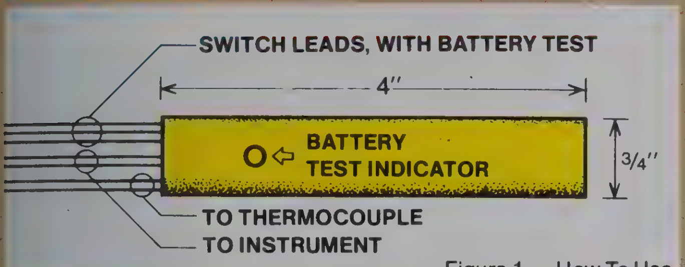


Figure 1 — How To Use

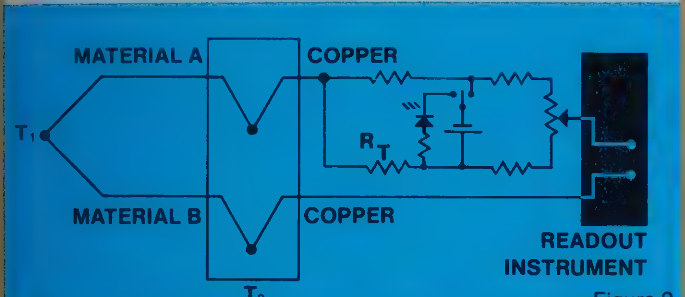


Figure 2

Unit contains a self-compensating electrical bridge network as shown in Figure 2. This system incorporates a temperature sensitive resistance element (R_T) which is in one leg of a bridge network and thermally integrated with the cold junction (T_2). The bridge is energized from a mercury battery. The output voltage is proportional to the unbalance created between the pre-set equivalent reference temperature at (T_2) and the temperature of the hot junction (T_1). In this system, the reference temperature is 0°C or 32°F.

As the ambient temperature surrounding the cold junction (T_2) varies, a thermally generated voltage appears and produces an error in the output. However, an automatic equal and opposite voltage is introduced in series with the thermal error. This cancels the error and maintains the equivalent reference junction temperature over a wide ambient temperature range with a high degree of accuracy.

By integrating copper leads with the cold junction, the thermocouple material itself is not connected to the output terminal of the measurement device, thereby eliminating secondary errors.

Design Features

Immediate Operation: Self-contained battery with solid state circuitry is operational immediately upon joining switch leads. All leads are 14″ long.

Built-In Battery Test: Unit contains a sealed, built-in battery test indicator. Connection of battery test leads causes an indicator to glow through a window in the side of the unit.

Flexible Application: Small size, 4″ L x 3/4″ Dia. permits easy installation or portability for most uses.

Available in Fifteen Thermocouple Calibrations

Performance Characteristics

Reference Temperature Setting: 0°C standard. Other references available.

****Compensation Accuracy:**
±1/4°C @ 25 ± 5°C ambient setting
± 1/2°C from 15°C to 35°C ambient temp.
± 3/4°C from 0°C to 50°C ambient temp.

Operating Life: Continuous use — up to 5000 hours. Intermittent use — up to 3 years.

Output Impedance: Less than 250 ohms standard.

Storage Temperature: −25°C to +75°C.

Lead Length: 14 inches, standard.

***For standard reference temperature setting and standard base material thermocouple wire.*

NOTE: TO PROLONG BATTERY LIFE, USE TEST LIGHT SPARINGLY.

ANSI Designation	TC Material		Catalog Designation	Color Code	Price
K	Chromel	Alumel	LXCJ-K	Yellow	$120
T	Copper	Constantan	LXCJ-T	Blue	120
E	Chromel	Constantan	LXCJ-E	Violet	120
J	Iron	Constantan	LXCJ-J	Black	120
S	Plat 10% Rh	Platinum	LXCJ-S	Green	*
SX	Plat 10 Ext.	Pt Ext.	LXCJ-SX	Green	120
R	Plat 13% Rh	Platinum	LXCJ-R	Green	*
RX	Plat 13 Ext.	Pt Ext.	LXCJ-RX	Green	120
	Tungsten 5% Re	Tungsten 26% Re	LXCJ-C	Red	*
	Alloy 405	Alloy 426	LXCJ-CX	Red	130
	Tungsten	Tungsten 26% Re	LXCJ-G	Red/Green	*
	Alloy 200	Alloy 226	LXCJ-GX	Red/Green	130
	Tungsten 3% Re	Tungsten 25% Re	LXCJ-D	Red/White	*
	Alloy 203	Alloy 225	LXCJ-DX	Red/White	130

**Consult Sales Department for price and delivery*

Design, construction and specifications subject to change. OMEGA ENGINEERING unconditionally guarantees materials and workmanship. Upon inspection by OMEGA, it will repair, replace, or refund the purchase price of any product or material found to be defective. Except for such repair, replacement, or refund, no other warranty is offered.

Discount Schedule:

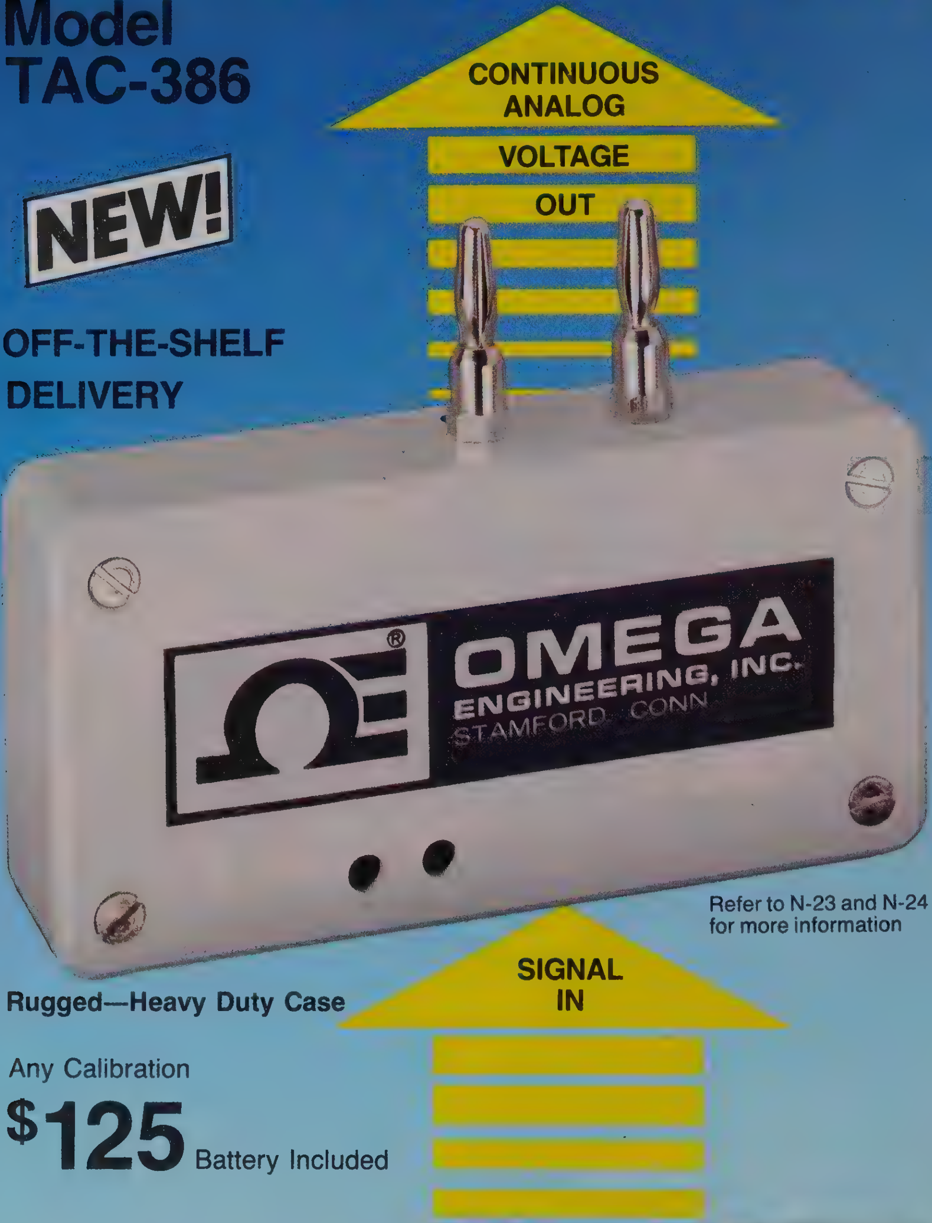
1-4 units	**Net**
5-9 units	**5%**
10-24 units	**7%**
25-49 units	**10%**
50 units and up	**15%**

Thermocouple to Analog Converter

Model
TAC-386

NEW!

OFF-THE-SHELF DELIVERY



Refer to N-23 and N-24 for more information

Rugged—Heavy Duty Case

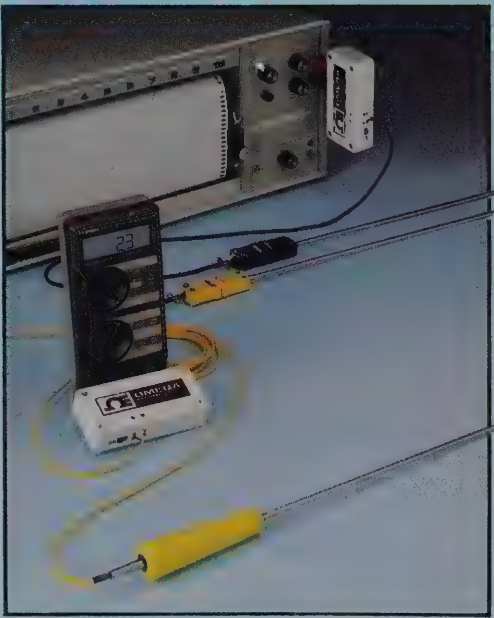
Any Calibration

$125 Battery Included

SPECIFICATIONS

Ranges:	J	−105° to 750°C
	K	−20° to 1200°C
	T	−86° to 350°C

Power: 9 V Alkaline Battery—MN1604
Accuracy: ±4°C over entire range
Response Time: 2 to 3 seconds
Reference Junction Stability: .05°C/°C
Input Conn.: Miniature Jack
Output Conn.: Std. Banana Jack ¾″ Spacing (19 mm)
Operating Temp.: 0° to 50°C
Storage Temp.: 0° to 65°C
Dimensions: W: 2½″ D: 3″ H: 2″



Convert any Millivolt Recorder or Meter to Read Temperature

The OMEGA TAC-386 can turn an chart recorder or analog or digital voltmeter into an accurate wide-range temperature measuring instrument. The TAC-386 is a universal thermocouple amplifier and linearizer which provides a precision 1mV/°C signal for the popular J, K, or T thermocouples. Cold junction compensation is standard.

Easy-to-Use
Set instrument to 200mV range fo readings of less than 200°C. Set instrument to 2V range for reading above 200°C. Your multimeter will read out directly in temperature—just transpose mV or V to °C.

- **Linearized and Compensated to 1 mV/°C**
- **Accurate**
- **Lo Power**
- **Accepts Miniature and Subminiature Connectors**

TO ORDER
Specify Model:

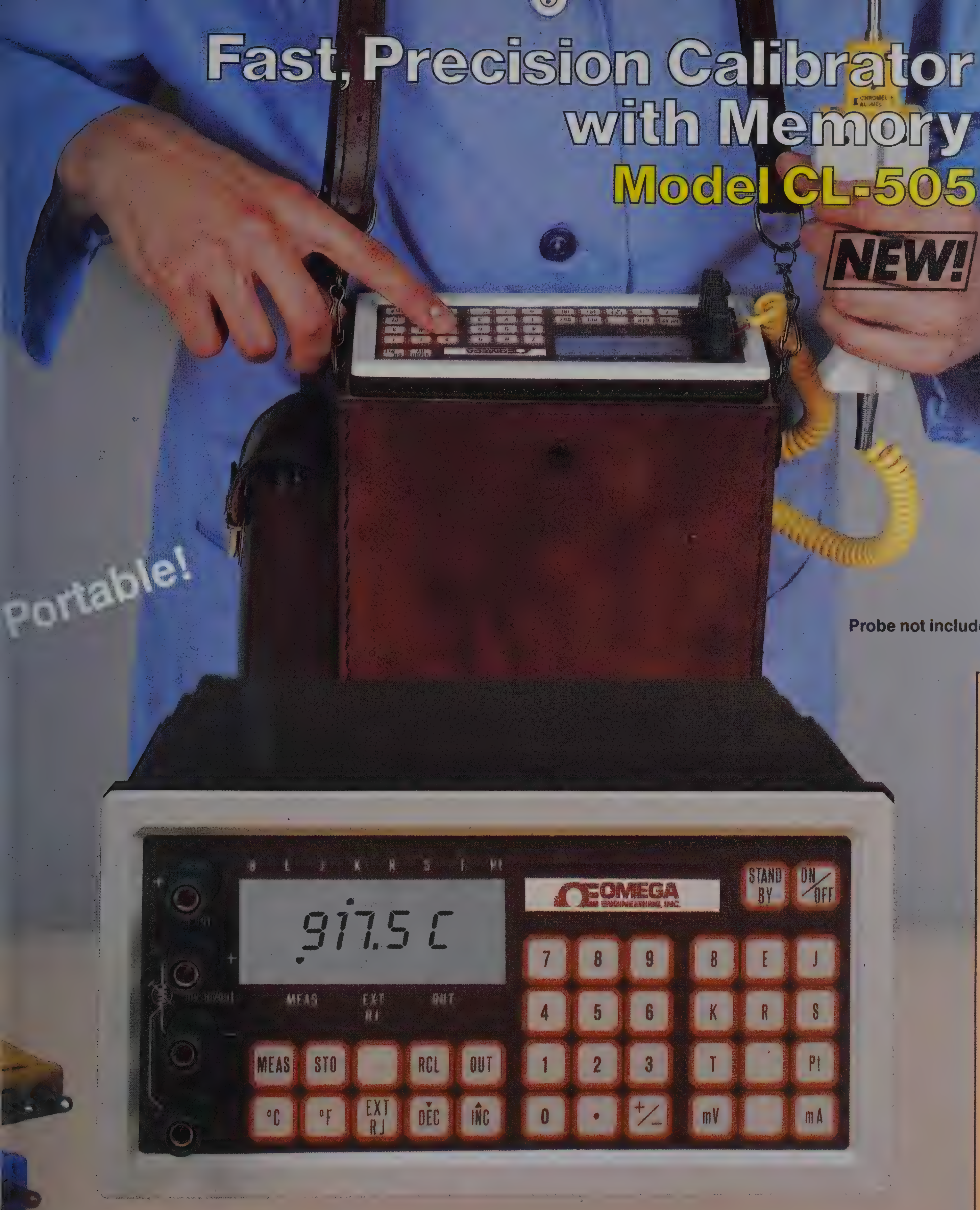
Model	**TAC-386-J** Type J T/C −105° to +750°C	$1
Model	**TAC-386-K** Type K T/C −20° to +1200°C	$1
Model	**TAC-386-T** Type T T/C −86° to +350°C	$1
	MN 1604 Replacement Battery	

See Section D for matching thermocouple probes

Fast, Precision Calibrator with Memory

Model CL-505

NEW!


OMEGA ENGINEERING, INC.
917.5 C
MEAS
EXT RJ
OUT
STAND BY
ON/OFF
7
8
9
B
E
J
4
5
6
K
R
S
1
2
3
T
Pt
0
•
+/_
mV
mA
MEAS
STO
RCL
OUT
°C
°F
EXT RJ
DEC
INC
CHROMEL + ALUMEL

Portable!

Probe not included

$1750 As Shown With Genuine Leather Carrying Case

Recalls 10 Points at the Touch of a Button

ludes Type K Beaded Wire Thermocouple

Fast, Precision Calibrator with Memory

Model CL-505

The calibrator that remembers up to 10 test points again and again…

- **Precision**
  Accuracy to 0.2°C
  Resolution to 5μV
- **Speed**
  Fast keyboard settings
  No knobs to turn
- **Portable—Rechargeable**
  Battery; 8 + hours
  Line Voltage; continuous
- **Easy-to-Use**
  Push button controls
  Custom liquid crystal display

Memory
10 separate output values can be stored and recalled at the touch of a key for fast repetitive readings!

Omegaline Recorder
OMEGA Engineering
B E J K R S T Pt
100.0 mV
MEAS EXT RJ OUT
OMEGA ENGINEERING, INC.
STAND BY
ON/OFF
7 8 9 4 5 6 1 2 3 0 • +/−
B E J K R S T Pt mV mA
MEAS STO RCL OUT
°C °F EXT RJ DEC INC

Measure/Simulate

- Thermocouples
  J, K, T, E, R, S, B
- RTD's (measure only)
  100Ω Platinum
  $\alpha = 0.00385$
- mA Milliamps
  Measure: − 10 mA to + 100 mA
  Source: 0 to 20 mA
- mV Millivolts
  − 10 mV to + 10 V

$1550

Add $200 for genuine leather carrying case ($1750)

PORTABLE OR PANEL MOUNT

In the Lab, the Field or Factory

- QA/QC Stations
- Troubleshooting
- Calibration Labs
- Production Test
- Dedicated Test Systems

HOW TO ORDER

CL-505	Precision calibrator for bench top or panel mount	$1550
SC-505	Leather carrying case with adjustable strap for portable applications	$200
CL-505-BTY	Extra Rechargeable Battery (one included in instrument)	$40

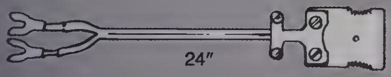
Hook-up Cables

Convenient pre-made cables make connections easy. Thermocouple type of cable and instrument to be calibrated must match. Specify cable option and thermocouple type for CL-505 Calibrator.

Cable Option-A—[ ]—[ ] Adaptor Cable $10

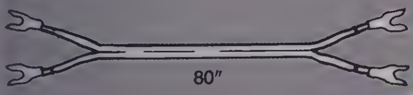
(T/C Type) J, K, T, E, R, S, C U2, U3 (Copper)

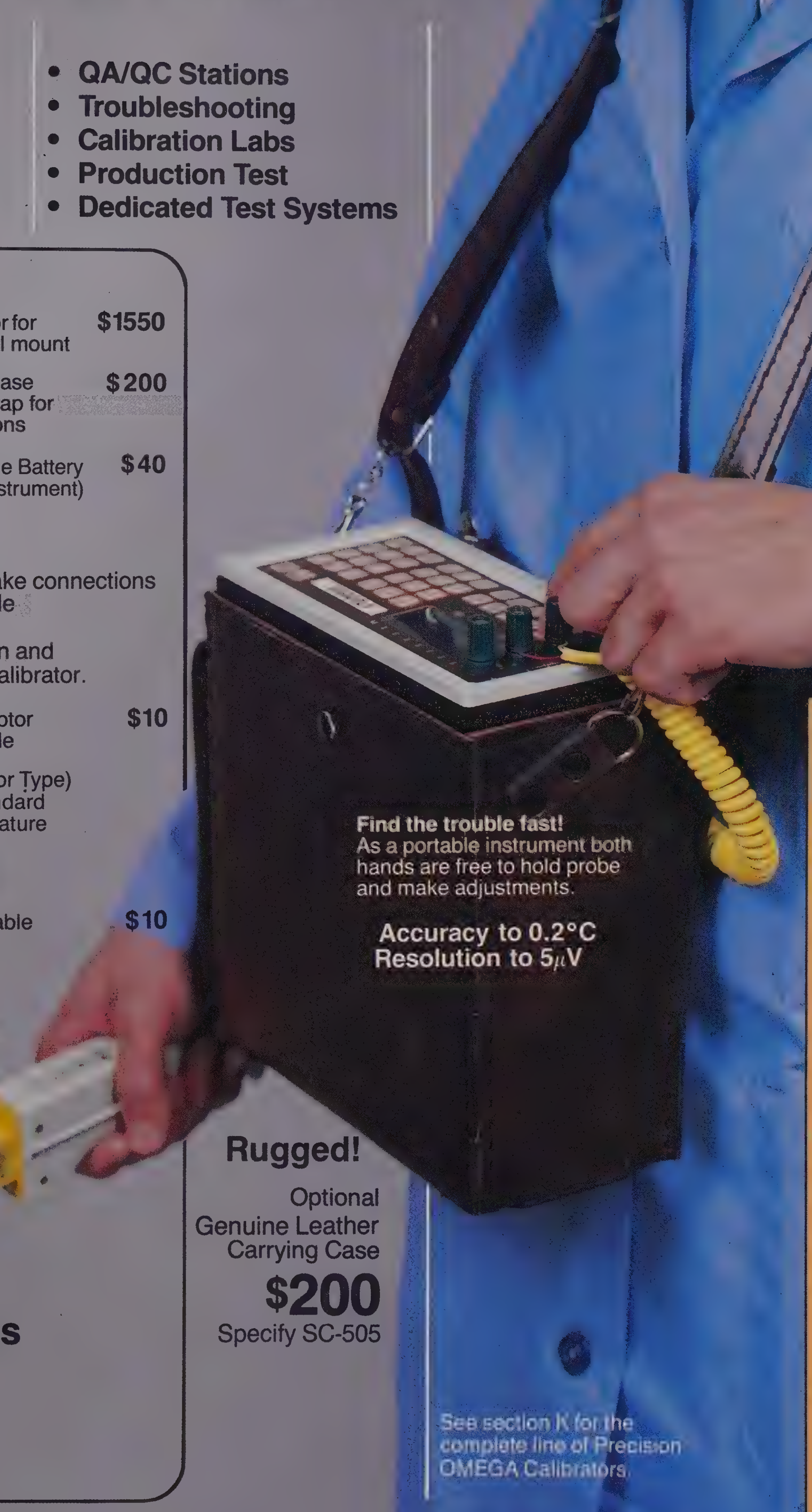
(Connector Type) STD Standard MIN Miniature



Cable Option-C—[ ] Service Cable $10

J, E, T, K, R, S, C (T/C Type)
U2, U3 (copper 2 or 3 wire)





Probe not included

Hundreds of Probes to Choose From!

See sections A and D for a complete selection of probes and handles.

Find the trouble fast!
As a portable instrument both hands are free to hold probe and make adjustments.

Accuracy to 0.2°C
Resolution to 5μV

Rugged!

Optional Genuine Leather Carrying Case

$200

Specify SC-505

See section K for the complete line of Precision OMEGA Calibrators.

K

CL-505 PRECISION CALIBRATOR

RANGE TABLE

Measured Simulated Thermocouples (Thermocouple Calibrator or Generator Mode)

Thermocouple Designation	Type of Input	Range	Accuracy* ±	Resolution
J	Iron-Constantan Thermocouple	−60 to +1600°F −50 to +870°C	0.9° ≤ 842° > 0.36° 0.5° ≤ 450° > 0.2°	0.5° ≤ 1000°F > 1° 0.1° ≤ 450°C > 0.5°
K	Chromel-Alumel Thermocouple	+32 to +2250°F 0 to +1230°C	0.36° ≤ 572° > 0.9° 0.2° ≤ 300° > 0.5°	0.5° ≤ 600°F > 1° 0.1° ≤ 300°C > 0.5°
T	Copper-Constantan Thermocouple	−261 to +750°F −163 to +400°C	0.36° 0.2°	0.5° 0.1°
E	Chromel-Constantan Thermocouple	−328 to +1220°F −200 to +660°C	0.36° ≤ 662° > 0.9° 0.2° ≤ 350° > 0.5°	0.5° ≤ 700°F > 1° 0.1° ≤ 350°C > 0.5°
R	Platinum-Platinum 13% Rhodium Thermocouple	+32 to +3220°F 0 to +1770°C	1.26° 0.7°	1° 1°
S	Platinum-Platinum 10% Rhodium Thermocouple	+32 to +3220°F 0 to +1770°C	0.7°	1°
B	Platinum 30% Rhod/ Platinum 6% Rhod Thermocouple	+32 to +3300°F 0 to 1820°C	1.26° 0.7°	10° 10°

***Accuracy includes max linearization error, A/D conversion, internal instrument noise, and cold junction compensation for 24 hours without zero or scale adjustment. All contributing errors are added together to produce worst case instrument accuracy.**

Measured RTD (Calibrator Mode)

Designation	Type of Input	Range	Accuracy* ±	Resolution
RTD	Platinum—100 ohm RTD	−328 to +1560°F −200 to +850°C	0.36° ≤ 626° > 0.9° 0.2° ≤ 330° > 0.5°	0.1° ≤ 330°C > 0.5°

Simulated mV (Voltage Generator Mode)—Max output current: 1 mA

Range	Resolution
±10 mV	5 μV
±100 mV	50 μV
± 1 V	0.5 mV
±10 V	5 mV

Simulated mA (Current Generator Mode)—Accuracy: ±0.05% of indicated value

Range	Resolution
0-20 mA	10 μA

Measured mA (Current Calibrator Mode)—Accuracy ±0.05% of measured value

Range	Resolution	Impedance
−10/+10 mA	5 μA	1 ohm
−100/+100 mA	50 μA	

Measured mV and V (Voltage Calibrator Mode)—Accuracy ±0.05% of measured value

Range	Resolution	Impedance
−10/+10 mV	5 μV	100 Mohm
−100/+100 mV	50 μV	100 Mohm
−1/+1 V	0.5 mV	100 Mohm
−10/+10 V	5 mV	2 Mohm

SPECIFICATIONS

MOUNTING

Bench, panel or portable (leather case optional). Straps on the case can be configured to allow unit to be slung from user's shoulder or neck.

POWER SUPPLY

117V/125V/160V/220V/240V ac (±10%), 50-60 Hz; Voltages selectable via rear switch.

DC OPERATION

Rechargeable Lead acid (jellied) battery (12 V, 1.5 AH) for eight hours of operation in calibration mode, and six hours in single generator mode at 70 degrees F operating temperature.

CHARGING SYSTEM

Internal rectifier supplied from ac line through power supply.

DISPLAY(S)

1) Liquid crystal display (LCD) for four digits of information
2) LCD indicator on display for
   - -Thermocouple types, 100 ohm RTD, milliamp (mA) millivolt (mV) mode selected
   - -Degrees C or F mode selected
   - -Measurement (mea) and output (out) mode selected
   - -External reference junction (EXT CJ) mode selected

ZERO DRIFT

Automatically compensated for in the range of 0-50 degrees C (32-120 degrees F)

SPAN DRIFT

0.002% per degrees C over the range of 0-50 degrees C (32-120 degrees F)

AUTO COLD JUNCTION COMPENSATION

From minus 20 to 60 degrees C (minus 4 to 150 degrees F) automatically selected with T/C and cal mode selection.

EXTERNAL COLD JUNCTION COMPENSATION

Auto cold junction compensation can be bypassed with mode selection, if external cold junction compensation is desired by operator.

DIMENSIONS

3.8 inches high (96 mm) × 7.56 inches wide (192 mm) × 7.87 inches deep (200 mm). [Does not include carrying case.] Weight: 8 lbs.

PANEL CUTOUT

3.62″ × 7.32″ +0.04-0.00. Panel mounting adaptors furnished with each unit.

CARRYING CASE

Heavy duty leather case optional.

Temperature Calibrator

OMNI-CAL™ Precision

8 Calibrators in 1

1999.0
°F
°C
+
T/C
-
A
B
+
T/C
-
K
T
E
R
S
J
C
mV
MEASURE
OFF
CALIBRATE
TEST
COARSE
FINE

Includes Type K Beaded Wire Thermocouple

- **Microprocessor Accuracy**
- **Rugged Portable Design**
- **Works Anywhere**

Applications

- Automotive/Diesel
- Chemicals
- Coal and Shale
- Cryogenics
- Metals and Heat Treating
- Power Generation
- Pharmaceutical and Food
- Pipelines and Refineries
- Microcircuit Furnaces

From

$1,395

Model 4A

19990
°F
°C
T/C
A
B
K
T
E
R
S
C
J
mV
OFF
MEASURE
CALIBRATE
TEST
COARSE
FINE

8 Calibrators in

Table A
Millivolt Ranges

Voltage Range	Resolution	RSS Calibration	Overall Accuracy 1 Year
−20.000mV to +20.000mV	0.001mV	±(0.005% of reading + 2 digits)	(±0.03% of reading + 5 digits)
−101.10mV to −20.00mV +20.00mV to +101.10mV	0.01mV	±(0.01% of reading + 1 digit)	(±0.03% of reading + 2 digits)

Table B Thermocouple Ranges*

T/C Type	Scale	Temperature Range	Resolution	Conformity	RSS Calibration Accuracy	Overall Accuracy 1 year
J (Fe/CuNi)	°F	− 346 to +2192	0.1	±0.2	±0.29	± 1
	°C	− 210 to +1200	0.1	±0.1	±0.17	± 0.6
K (NiCr/NiAl)	°F	− 328 to +2501	0.1	±0.2	±0.33	± 1
	°C	− 200 to +1372	0.1	±0.1	±0.19	± 0.6
T (Cu/CuNi)	°F	− 337 to + 752	0.1	±0.2	±0.25	± 1
		− 405 to − 337	0.1	±9.2	±9.11	±10
	°C	− 205 to + 400	0.1	±0.1	±0.15	± 0.6
		− 243 to − 205	0.1	±5.1	±5.10	± 5.6
E (NiCr/CuNi)	°F	− 389 to +1832	0.1	±0.2	±0.27	± 1
		− 422 to − 389	0.1	±5.0	±4.81	± 5
	°C	− 234 to +1000	0.1	±0.1	±0.16	± 0.6
		− 252 to − 234	0.1	±2.8	±2.71	± 2.8
R (Pt13% Rh/Pt)	°F	− 58 to +3214	1	±0.2	±0.76	± 2
	°C	− 50 to +1768	1	±0.1	±0.65	± 1.1
S (Pt10% Rh/Pt)	°F	− 58 to +3214	1	±0.2	±0.61	± 2
	°C	− 50 to +1768	1	±0.1	±0.54	± 1.1
C (W5%Re/W26% Re)	°F	+ 32 to +2192	1	±0.1	±0.68	± 1
		+2192 to +3812	1	±0.2	±0.84	+ 2
		+3812 to +4200	1	±0.2	±0.97	± 3
	°C	0 to +1200	1	±0.1	±0.56	±0.6
		+1200 to +2100	1	±0.1	±0.62	± 1.1
		+2100 to +2315	1	±0.1	±0.69	± 1.7

* All values in degrees

Brings Laboratory Accuracy into the Field

The OMNI-CAL™ is a new type of compact, rugged temperature computer for use with temperature instruments in manufacturing, process nd service industries as well as in aboratories. It is a calibrator, a linear millivolt source, a thermocouple eadout device and a millivolt meter.

S A CALIBRATOR

The OMNI-CAL™ supplies a cold unction compensated output signal corresponding to the thermocouple ype and temperature selected, and gives a 0.1° or 1° resolution readout or easy comparisons. Course and ine adjustments allow any temperaure to be selected from −122 to 4224°F (−252 to 2315°C) depending upon thermocouple type. Because the signal is generated under microprocessor control, it provides high accuracy and conformity o standard thermocouple data tables over their full published ranges.

As A Millivolt Source

The OMNI-CAL™ provides a linear millivolt signal from −101 mV to +101 mV with 0.01 mV resolution and from −20 mV to +20 mV with 0.001 mV resolution. Accuracy as high as ±0.003% of reading plus 5 digits is achieved on the ±20 mV ange!

As A Thermocouple Readout

The OMNI-CAL™ supplies cold junc-ion compensation and linearization o the thermocouple signal to provide accurate temperature readings in Celsius or Fahrenheit from a connected thermocouple. A precision 0.1° readout is provided for base metal thermocouples types J, K, T, and E, and a 1° readout is provided for high temperature platinum and tungsten thermocouples types R, S, and C.

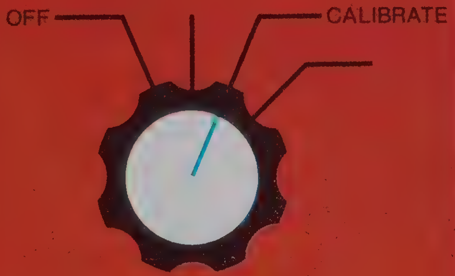
As A Millivolt Meter

The OMNI-CAL™ functions as a dual range 4½ digit meter with autoranging. Between −20 mV to +20 mV a typical display would be 10.123 mV, 1 microvolt resolution! From −101 mV to −20 mV and +20 mV to +101 mV the resolution is 0.01 mV.

Easy To Use

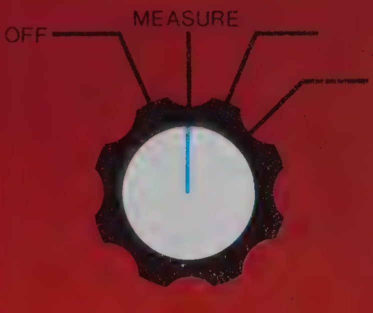
OMNI-CAL™ provides many timesaving features, from a clear digital readout to flexible, quick connection for two sets of leads. The following operations are completed sooner when using OMNI-CAL™.

To Calibrate:



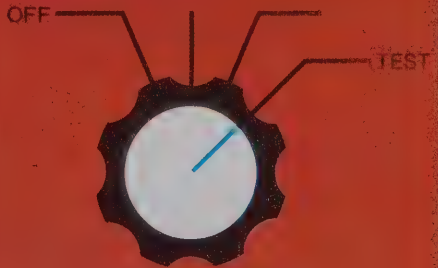
1. Disconnect the thermocouple leads from the instrument to be calibrated.
2. Use appropriate thermocouple wire to connect the instrument to the OMNI-CAL™.
3. Select the OMNI-CAL™ CALIBRATE function.
4. Select the appropriate thermocouple type.
5. Select OMNI-CAL™ temperature scale °F/°C to match the instrument being calibrated.
6. Use OMNI-CAL™ Coarse and Fine OUTPUT ADJUST controls for a 0° display value.
7. Adjust the instrument ZERO for 0° on the instrument display.
8. Use OMNI-CAL™ OUTPUT ADJUST controls for an instrument full scale range output value.
9. Adjust the instrument RANGE (GAIN or SPAN) control for equal instrument display.

To Measure Temperature:



1. Connect your thermocouple to the thermocouple input terminals of OMNI-CAL™. You may use either pair of thermocouple terminals. Observe caution in connecting proper polarities. The red thermocouple lead is to be connected to the negative binding post terminal; connect the other lead to the positive terminal.
2. Turn the A/B channel select switch to the connected terminal pair.
3. Rotate the RANGE selector switch to the appropriate thermocouple type.
4. Rotate the FUNCTION selector switch to the MEASURE function.
5. Select the desired temperature scale: °C/°F.
6. Read the temperature in the display. The value has been compensated automatically for the reference junction temperature.

Instant Self-Test



Check your OMNI-CAL™ in seconds:

1. Select the TEST function and the RANGE (thermocouple type).
2. Compare the digital display to the corresponding reference reading printed inside the cover.

You have now verified that OMNICAL™ is functioning correctly!

Temperature Calibrator
OMNI-CAL™ Precision
Brings Laboratory Accuracy into the Field

$1,395

$1,595

Specifications (60° - 95°F)

Millivolt Inputs

Ranges, Resolution, & Accuracy:	See Table A
Range Tempco:	Same as thermocouple inputs
Overload Protection:	Same as thermocouple inputs

Thermocouple Inputs

Types, Ranges & Resolution:	See Table B
Reference Junction: Compensation:	Automatic. 0.017° /degree From 59° to 95°F (15° to 35°C)
Zero Stability:	0.2μV/½°F (RJC)
Range Tempco:	15ppm/°C typical
Overload Protection:	120V dc or 120V ac rms, continuous

Calibrator Outputs

Range:	−12mV to +80mV
Resolution:	1μ V (typical)
Source Impedance:	40Ω

Electrical Noise Rejection

Normal Mode Rejection:	50dB @ 50/60Hz
Common Mode Rejection:	140dB with 300V ac isolation for recharge-mode

Power

Battery-Mode:	8 hours continuous operation minimum, for NiCad battery pack
Low Battery Indication:	Display blinks
Battery Life:	Minimum 1,000 charge/discharge cycles
Recharge-Mode:	14 to 16 hours for full charge. Instrument can be operated continuously and indefinitely while on recharge
Recharge Source:	110V ac or 220V ac, ±20%, 47 to 400Hz. Includes line cord for specified power source. Externally accessible fuse
Primary/ Secondary Transformer Isolation:	1400V ac

Environment and Reliability

Weight:	9.5 lb (4.3 kg)
Dimensions:	H: 8″ (203mm) × W: 12.5″ (317mm) × D: 6″ (152mm)
Operating Temperature:	14° to 104°F (−10° to +40°C)
Storage Temperature:	−40° to +140°F (−40° to +60°C)
Relative Humidity:	0-90% noncondensing
Moisture Seal:	O-ring sealed waterproof case; splash-proof panel
Vibration:	Each unit vibrated at 5g for 30 seconds
EMI/RFI:	Shielding on six sides in standard metal case
Burn-in:	100 hrs min (without batteries), with temperature cycles from 32° to 130°F (0° to 54°C) plus power ON/OFF cycles
Calibration:	NBS traceable. Detailed Certificate of Conformance shipped with each unit
Safety:	Meets requirements of ANSI C39-5-1974 for Electrical Safety

Two Models

4 Range

OMNI-CAL™ 4A incorporates the three most popular thermocouple ranges J, K, T, with readout in degrees F or C, and a versatile millivolt range.

8 Range

OMNI-CAL™ 8A has all the features of OMNI-CAL™ 4A plus four additional thermocouple ranges, E, R, S and C.

The J, K, T, and E thermocouple ranges have 0.1° resolution. The R, S, and C types have 1° resolution. All have automatic reference junction compensation. Both models also have a linear mV range without reference junction compensation.

How To Order Your OMNI-CAL™

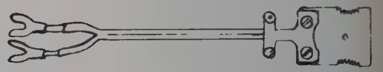
Product	Ordering Guide	
OMNI-CAL™ —[1]—[2]		
$1,395	4A	4 Range, mV, J, K, T
$1,595	8A	8 Range, mV, J, K, T, E, R, S, C
Standard	110	110V ac (U.S. Line Cord)
$25	220	220V ac (European Line Cord)

Options and Accessories

Option-A—[ ]—[ ] Adaptor Cable **$10**

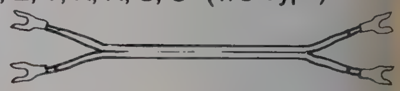
J, E, T, K, R, S, C (T/C Type)

(Connector Type)
S Standard
M Miniature



Option-C—[ ] Service Cable **$10**

J, E, T, K, R, S, C (T/C Type)



Accessories: Instruction Manual (Supplied)
Extra copies **$10**

Digital Calibrators for Thermocouples—mV and mA Devices

NEW!

CALIBRATE ANALOG METERS
CALIBRATE TRANSMITTERS
CALIBRATE DIGITAL METERS
1152.8
°F °C J K T E mA mV
Power Pack/Potentiometer
PULL-ON
PUSH-OFF
OUTPUT
LOW
ON
OFF
BATTERY
INPUT
OUTPUT
CAL TEST
TC
mV
mA
OMEGA ENGINEERING
DIGICATOR 466
OMEGA
TX 52
THERMOCOUPLE TRANSMITTER
TYPE K THERMOCOUPLE THERMOMETER
1153°C
OMEGA ENGINEERING INC
MODEL 650

See **Section A** for Additional Probes and Handles.

Two functions simultaneously—

- **Simulate transmitter input**
- **Display transmitter output**

$1,595

"Off-the-Shelf" DELIVERY

Test Probe and Handle Included

Now! Process calibration and temperature measurement from one reliable, portable instrument.

Exclusive Model CL-466 Features

The OMEGA® Model CL-466 offers a single portable instrument that can calibrate and measure thermocouple signals, process voltages, and signals from current transmitters.

Calibrate temperature/millivolt transmitters with a single piece of equipment! With the Model CL-466 you can output a compensated thermocouple signal, and simultaneously display the transmitter's current output.

This convenient multifunction instrument has the flexibility you need to handle instrument checkout in the field or in the laboratory. There's no need for voltage sources, ice baths, and thermocouple look-up tables. The Model CL-466 provides a high-resolution, electrically compensated source or measurement signal for six different ranges—selected at the touch of a button.

Built-in Assurance of Accuracy

Incorporating electronics created exclusively for the Model Series 400 indicators, DIGICATOR™ CL-466 is designed and built to deliver the long-term accuracy you must have.

OMEGA has also strengthened what was once the weakest link in calibration—the interface between thermocouple and calibrator. Here, we utilize an OMEGA special compensated mini-connector. The easy-to-use mini-connector is recessed into the instrument, not "out in the wind." In addition, our reference junction has been built into the connector, assuring proper thermal tracking of all thermocouple connections. The result: True, exact readings in all environments.

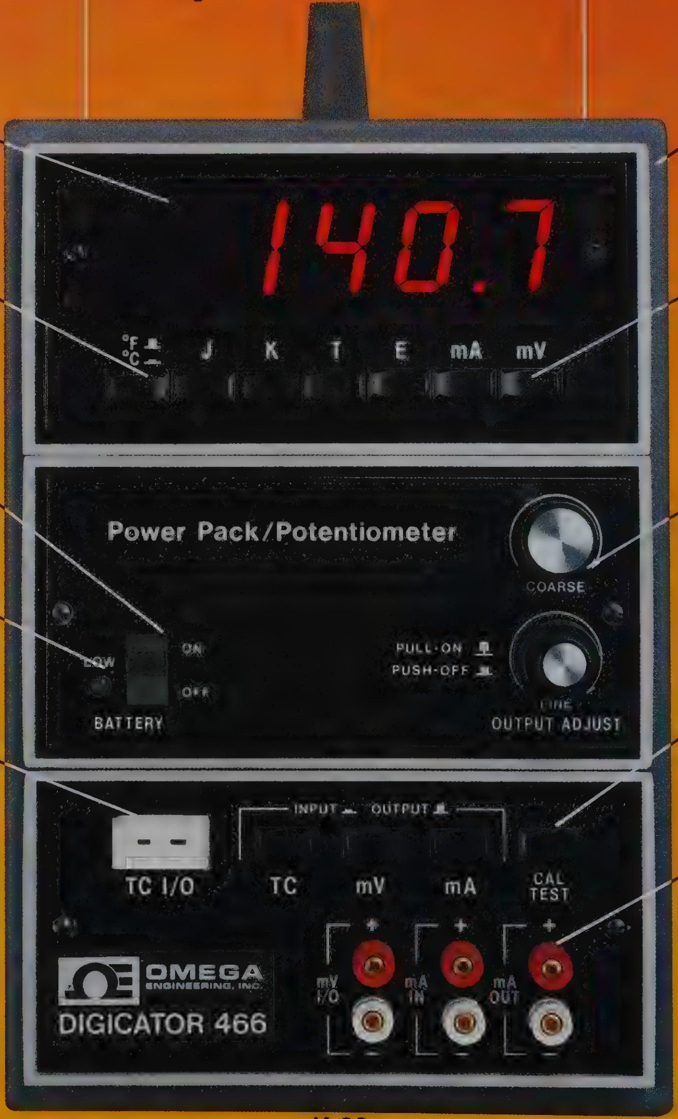
Probe and Hook-up wires included

Each DIGICATOR™ CL-466 comes complete with a type K test probe, a quick disconnect handle and a set of thermocouple wires with mating compensated mini-connectors.

There's no need to hunt around for the right thermocouple or wires to do the job. Just connect the wires supplied between the unit and the input terminals of the instrument to be calibrated, and you're ready to go! Use the probe to verify readings.

Versatile, easy-to-use, and accurate over the long haul

The OMEGA CL-466 is a unique calibrator that works with thermocouples, milliamps, and millivolts. You can measure and



Digital Display—Large 0.8″ LEDs call out the numbers loud and clear.

°F or °C Selector—Selects T/C measurement range.

Battery On/Off Switch—Chooses AC or battery operation.

Low Battery LED—Warns when battery is low.

The OMEGA Exclusive Thermocouple Connector—Special compensated mini-connector for easy, accurate thermocouple connections.

Rugged Case—Metal construction protects electronics inside.

Range/Function Select Push buttons—Easy selection of any six functions.

Calibrator Output Controls—"Coarse" 10-turn potentiometer adjusts output to within the range of the "Fine" control, which then adjusts output to within 0.1.

Self-Test—Provides fixed reference source to check calibration of each measurement function.

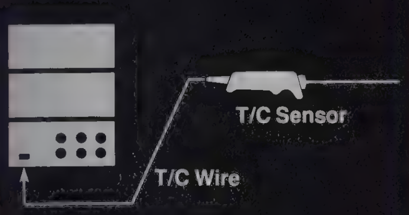
Voltage and Current Connectors—Dual 5-way binding post design.

$1,595

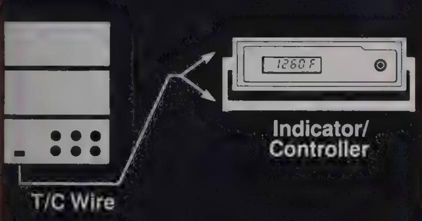
"Easy-to-Use"

Operating Modes

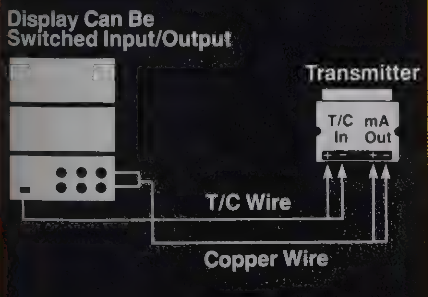
I. Temperature Indicator



II. Instrument Calibrator



III. Transmitter Calibrator



calibrate in any of the six ranges—input as well as output. You have the portability needed for work at the process—and the accuracy demanded for laboratory duty.

Even the power source is flexible. Use built-in rechargeable batteries—or ac line power for continuous use.

As a multiple input indicator, it can be used to measure temperatures in everything from ovens to laboratories.

As a calibrator, it can be used on panel meters, data loggers, controllers, recorders, pyrometers, potentiometers, transmitters, test instruments, and computer inputs.

DIGICATOR™ makes quick work of any measurement or calibration task

Pushbutton controls assure easy use and direct digital readings eliminate calculations and reduce the chance of operator errors. Results are instantly displayed on large, 0.8″ LEDs—more than twice the size of other calibrators. Viewing is easy, even in low light conditions.

A Choice of Models to Meet Your Exact Requirements

Model CL-466L

Covers the four most popular thermocouples—J, K, T, and E—plus 0-20 mA current and −10 to +100 mV linear dc voltage.

Model CL-466T

Designed specifically for dedicated thermocouple temperature applications, accommodates the six most common types—J, K, T, R, S, and B.

EITHER MODEL $1,595

with interchangeable Test Probe (Type K) and Quick Disconnect Universal Handle.

OMEGA® DIGICATOR™ CL-466

Version L Range Table

Range	Type of Input	Range	Resolution	Accuracy* (±)
J	Iron-Constantan Thermocouple	−328° to +1712°F −200° to + 933°C	0.1°	0.6°F 0.5°C
K	Chromel-Alumel Thermocouple	−208° to +2552°F −133° to +1400°C	0.1°	1.2° < 0° < 0.8°F 0.8° < 0° < 0.5°C
T	Copper-Constantan Thermocouple	−328° to + 752°F −200° to + 400°C	0.1°	0.5°F 0.5°C
E	Chromel-Constantan Thermocouple	−328° to +1952°F −200° to +1066°C	0.1°	0.7°F 0.4°C
mA	Current	0 to 20 mA	1μA	0.01% rdg. ±1 count
mV	dc Volts	−10 to 100 mV	10μV	0.01% rdg. ±1 count

Version T Range Table

Range	Type of Input	Range	Resolution	Accuracy* (±)
J	Iron-Constantan Thermocouple	−328° to +1712°F −200° to + 933°C	0.1°	0.6°F 0.5°C
K	Chromel-Alumel Thermocouple	−208° to +2552°F −133° to +1400°C	0.1°	1.2° < 0° < 0.8°F 0.8° < 0° < 0.5°C
T	Copper-Constantan Thermocouple	−328° to + 752°F −200° to + 400°C	0.1°	0.5°F 0.5°C
R	Platinum-Platinum 13% Rhodium Thermocouple	+ 32° to +3252°F 0° to +1788°C	0.1°	3° < 350° < 1.5°F 2° < 200° < 1.0°C 0.6° above 800°C
S	Platinum-Platinum 10% Rhodium Thermocouple	+ 32° to +3252°F 0° to +1788°C	0.1°	3° < 600° < 1.5°F 2° < 315° < 1.0°C 0.5° above 800°C
B	Platinum 6% Rh/ Platinum 30% Rh Thermocouple	+912° to +3392°F +489° to +1866°C	0.1°	2.5°F 1.0°C

*Includes errors due to linearization, A/D conversion, internal instrument noise, and ±10% line voltage variation at 25° ±3°C (77° ±5°F) for 24 hours without zero or scale adjustment. All contributing errors are added together to produce worst case instrument accuracy.

Specifications and Accessories

Input

Input Impedance: Thermocouples: > 10 Megohms
mV: 1000 Megohms
mA: 5 ohms

Repeatability: ±1 digit (J, K, T, mA and mV), ±2 digits (R, S and B)

Temperature Stability: Zero: 0.5μV per °C
Span: 0.005% of reading per °C
Reference Junction: 0.025 degrees per degree (10° to 40°C)

Noise Rejection: Common Mode Rejection: 120 dB @ 60 Hz with 250 ohm imbalance
Normal Mode Rejection: 60 dB @ 60 Hz

Output

Ranges: Thermocouple/mV: −10 mV to 100 mV
Milliamps: 4 to 20 mA into 0 to 150 ohms

Output Impedance: Thermocouple/mA: 1 ohm

Physical

Size: H: 9.13″ × W: 6.13″ × D: 7.9″ (232mm × 155mm × 200 mm)

Weight: 11.5 lbs. (5.175 kg.)

Power: Line Voltage: 110 to 125 or 190 to 250 V ac, jumper selected 48 to 400 Hz; 1.5 Watts, typical (5 W when charging)

Battery: 10 V rechargeable; 2 to 4 hours (typical) continuous operation with full charge; recharge time, 14 hours maximum

Input/Output: Thermocouples: Cables with compensated mini-connectors (set supplied with instrument)

mA & mV: 5-way miniature binding posts

Construction: Metal chassis, RFI/EMI shielded

Environmental Temperature: Operating Range: 0 to 50°C
Storage Range: −40 to 60°C

Relative Humidity: 0 to 90% RH, non-condensing (to 40°C)

Thousands of Probes and Assemblies can be found in Sections A, B and D.

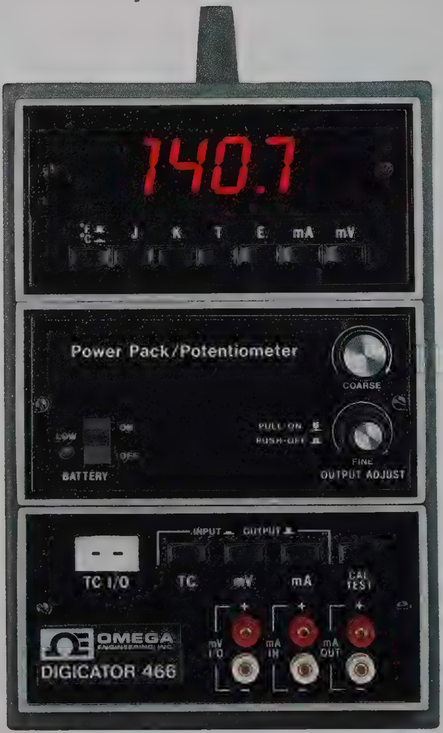
Accessories:

Model No. 466T-Cable Kit:
Extra set of four thermocouple cables with compensated mini-connectors for types J, K, T, R, S and B. The same cable is shared by types R, S and B. Length 6 ft., 24 gage. **$35.00**

Model No. 466L-Cable Kit:
Extra set of four thermocouple cables with compensated mini-connectors for types J, K, T and E. Length 6 ft., 24 gage. **$35.00**

Model No. HDX-466-☐-Kit
Extra probe and handle kit. Specify thermocouple type J, K, T or E. 1 ft. retractile cord stretches to 5 ft. Probe ⅛″ O.D., 12″ long, grounded tip. (Note: One complete type K kit included with your CL-466.) **Special $59.00**

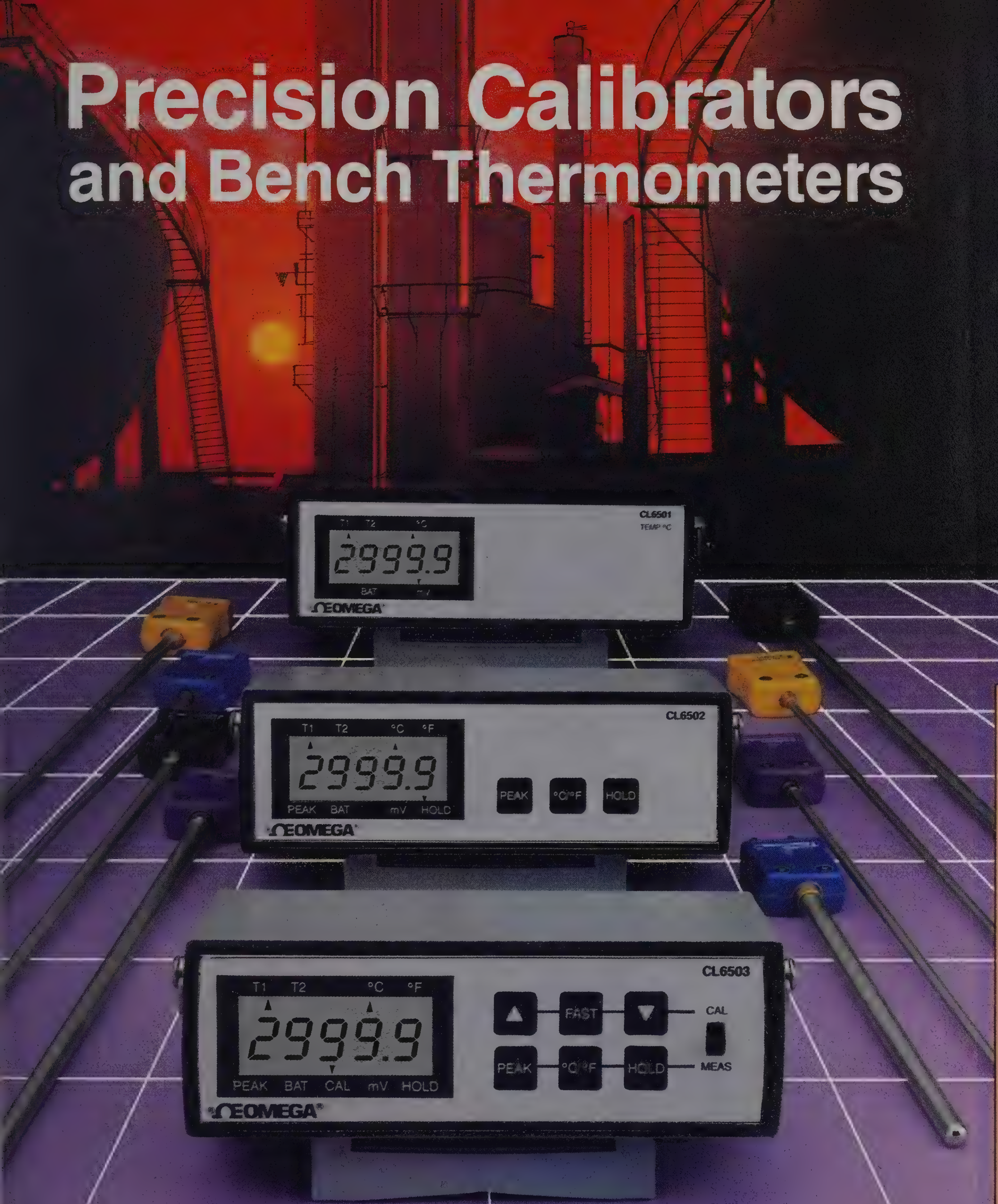
Model No. 466-RB-Replacement Battery $65



Order your OMEGA® DIGICATOR™ CL-466—$1,595

1. **Identify Basic Instrument** **Model CL-466-[ ]-[ ]**
   Includes Test probe, rugged quick disconnect handle, hook-up wire kit, owner's manual and power cord.
2. **Specify Range Version**
   Write in [**T**] for J, K, T, R, S and B thermocouples (temperature only).
   Write in [**L**] for J, K, T, E, mV and mA (temperature and process).
3. **Select Power**
   Write in [**1**] for 115 V ac. Write [**2**] for 230 V ac.
4. **Select additional accessories (see list).**
   Call Today.

Precision Calibrators and Bench Thermometers


CL6501
TEMP °C
T1 T2 °C
2999.9
BAT mV
OMEGA
CL6502
T1 T2 °C °F
2999.9
PEAK BAT mV HOLD
PEAK
°C/°F
HOLD
OMEGA
CL6503
T1 T2 °C °F
2999.9
PEAK BAT CAL mV HOLD
FAST
CAL
PEAK
°C/°F
HOLD
MEAS
OMEGA

NEW!

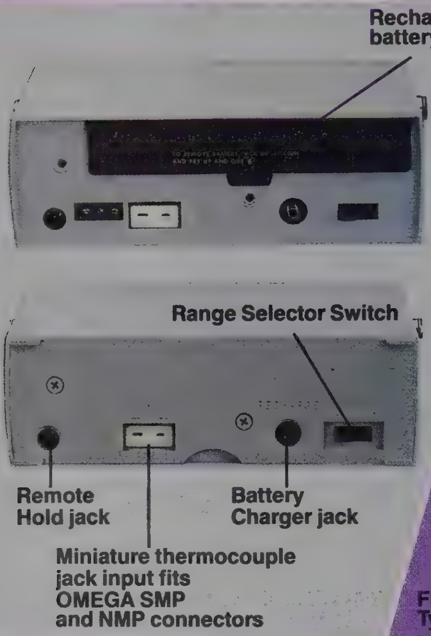
Series CL-6500

Prices start at

$460

Precision Calibration and Measurement Instruments

FULLY PORTABLE

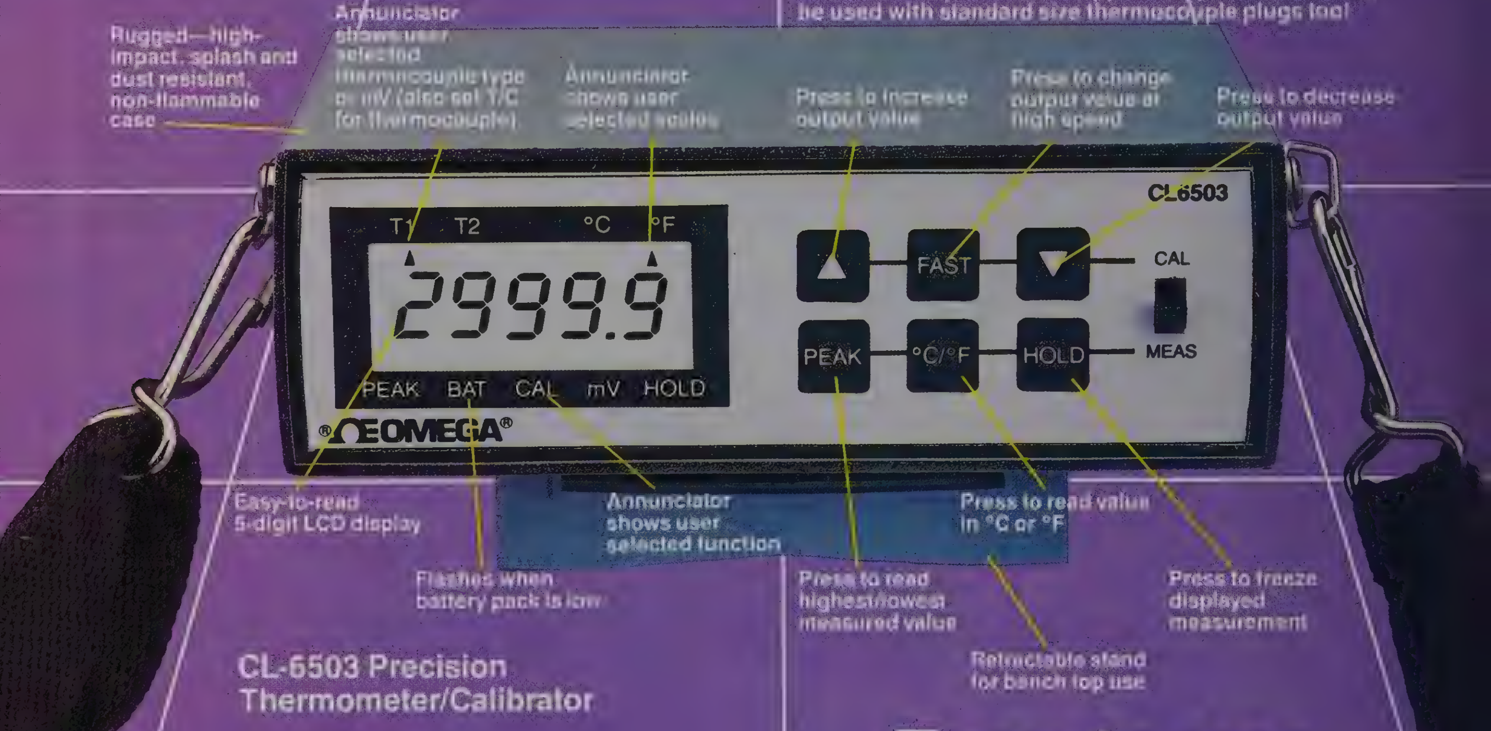

Rechargeable
battery pack
Range Selector Switch
Remote
Hold jack
Battery
Charger jack
Miniature thermocouple
jack input fits
OMEGA SMP
and NMP connectors

FREE Adaptor

FREE
Type K beaded wire thermocouple
with convenient SMP connector

FAST CONNECTIONS

The Rear Panel Connector accepts all miniature or subminiature thermocouple plugs. A FREE standard to miniature adaptor is also supplied so your CL-6500 can be used with standard size thermocouple plugs too!


Rugged—high-impact, splash and dust resistant, non-flammable case
Annunciator shows user selected thermocouple type or mV (also set T/C for thermocouple)
Annunciator shows user selected scales
Press to increase output value
Press to change output value at high speed
Press to decrease output value
CL6503
T1
T2
°C
°F
2999.9
PEAK
BAT
CAL
mV
HOLD
OMEGA
FAST
CAL
PEAK
°C/°F
HOLD
MEAS
Easy-to-read 5-digit LCD display
Annunciator shows user selected function
Press to read value in °C or °F
Flashes when battery pack is low
Press to read highest/lowest measured value
Press to freeze displayed measurement
Retractable stand for bench top use

CL-6503 Precision Thermometer/Calibrator

$765

Easy-to-use

Specifications

Diagnostic Displays

Low Battery: Battery annunciator blinks during a 5-minute warning period, then the unit powers down and the display turns off.

Positive Temperature Overrange: "HI"

Negative Temperature Overrange: "LO"

Open Thermocouple Input: "LO"

Overrange mV Input: "HI"

Display Test: Display reads all "8's" when unit is turned on or range is changed

Environmental & Reliability

Operating Temperature: 0°C to +50°C

Storage Temperature: (+32°F to 122°F)

Relative Humidity: 0 to 85%, non-condensing

Moisture Seal: Splash resistant panel

Vibration: Each unit vibrated at 5g RMS for 30 seconds

Shock (drop test): Meets the requirements of MIL-STD 202-E for safe transit

Burn-in: 100 hours min. with temperature cycles from 0°C to +50°C (+32°F to +122°F), and power ON/OFF cycles. Battery pack is installed after burn-in prior to final calibration

MTBF (Calculated): 25,000 hours, excluding batteries and display

Warranty: Twelve months

Operator Safety: 250 V ac RMS max. on input terminals

Size: 2″ (50mm) H; 5.5″ (140mm) W; 3.75″ (95mm) D

Weight: 1.5 lbs

CL-6501 Precision Bench Thermometer

- 0.1° Resolution
- 11 Switchable Thermocouple Types
- High Accuracy

CL-6502 Precision 3 Function Bench Thermometer

- Peak/Valley Reading
- Display Hold
- °C/°F Switchable

CL6501
TEMP °C
T1
T2
°C
2999.9
BAT
mV
OMEGA
CL6502
T1
T2
°C
°F
2999.9
PEAK
BAT
mV
HOLD
OMEGA
PEAK
°C/°F
HOLD

$460
CL-6501

$560
CL-6502

Series SDX Handle Probes prices start at **$35**

See Section A

Probes not included with Series CL-6500 instruments.

See Section A

Type SCASS miniature probes prices start at **$24**

Precision Calibration and Measurement Instruments

Calibrator, Thermometer

A single display clearly indicates temperature or millivolt data, instrument setup, and thermocouple faults. Five digits read from −200 to +1820°C (−328 to 3308°F) or −9.998 to +99.998mV. Annunciator arrows show the selected mode, range, unit of measure, hold and peak functions. And after nearly 8 hours of continuous use on a single charge, the battery annunciator will flash, alerting you to recharge—well in advance of power loss.

Moreover, if calibrator output or input exceeds the selected T/C range, the display reads "HI" for overrange and "LO" for underrange or an open thermocouple condition. Whether measuring or calibrating, the OMEGA CL-6503 has the information you need…on one easy-to-read display.

Choose from 3 models to meet your specific tasks.

CL-6501 $460

As a digital thermometer, you simply switch-select the thermocouple type or mV range—plug in the miniature thermocouple connector—and read the temperature or voltage.

CL-6502 $560

All the convenience of the CL-6501, PLUS—if you want to freeze the displayed reading, press HOLD. If you need to know the temperature high (or low), press PEAK and the extreme value will be displayed and held. If you want to change readings to °C or °F, press the button. It's that easy!

CL-6503 $765

All the convenience of the CL-6501 and CL-6502, PLUS—as a simulator, you switch-select CAL Mode and T/C type, connect simulator to the instrument being calibrated and it's ready for use. Calibration is a quick, push button operation. Press CAL FAST to cover the full output range in seconds, then press CAL UP or DOWN to home in on a precise reading. Within seconds you can check thermocouple function, monitor temperature, or calibrate instrumentation to maximum accuracy.

Easy, time saving operation

The microprocessor-controlled, full capability CL-6503 provides thermocouple simulation and temperature measurement of any two T/C ranges—selected from 11 types—plus millivolts. Other functions include a direct reading LCD display in °C or °F and push buttons to automatically record peak temperature, freeze the present reading, and control calibrator output…all of the functions you need to keep your thermocouple instruments operating at peak efficiency. Never before has so much capability been combined in one compact, rugged unit.

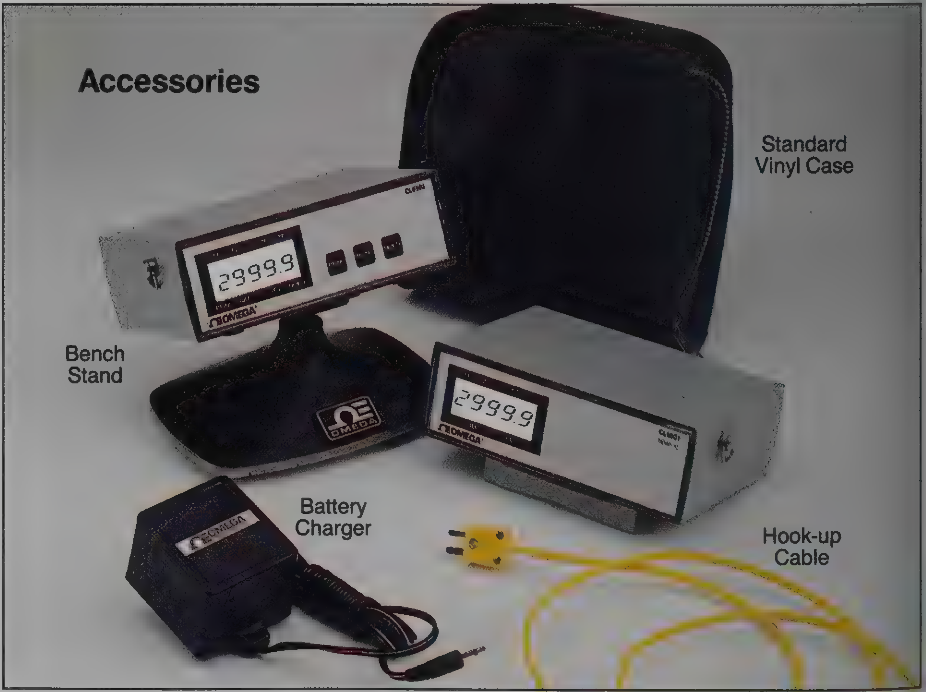
The CL-6502 and CL-6501 are digital thermometers with many of the performance features of the CL-6503—you purchase only the capability you need. The CL-6502 is a digital thermometer with PEAK, HOLD and °C/°F selection and the CL-6501 is simply a high accuracy, portable thermometer with a dedicated °C or °F display.

Goes anywhere you can

Weighing less than 1½ pounds, the standard sealed unit is resistant to water, chemicals, dust, vibration and shock. A choice of two cases equip the instrument for a variety of carrying options—a standard zipper-sealed, vinyl case supplied with each instrument and an optional snap-closed case for belt or around-the-neck transport. In addition, a retractable stand folds into the case for bench-top use. Styled for your comfort and convenience, yet able to operate in temperatures from 0 to +50°C, these instruments will work wherever you do.

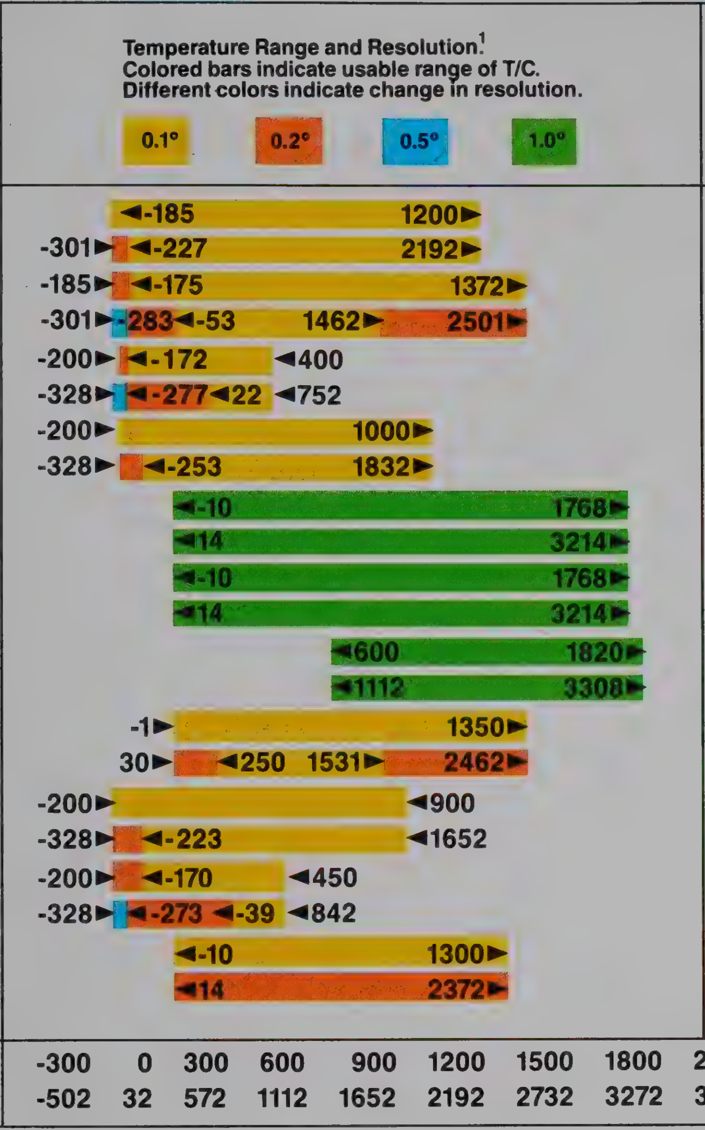
Performs with laboratory Precision

A 5-digit liquid crystal display indicates temperature with 0.1 degree resolution for any thermocouple types you select, plus millivolts. The instrument covers the complete published temperature range for all thermocouples; from −200 to +1820°C (−328 to +3308°F). Using a state-of-the-art microcomputer and precision reference circuitry, thermocouple output is linearized to 0.2°C and cold junction compensated…with microvolt resolution. Now you can measure temperature and calibrate instrumentation in the field with laboratory precision.



Choose from Eleven Thermocouples

Thermocouple Functions



T/C Type		Conformity[2] ±°C/°F	RSS Accuracy[3] ±°C/°F	Overall Accuracy[4] ±°C/°F
J	°C °F	0.23/0.41	0.29/0.53	0.74/1.34
K	°C °F	0.23/0.41	0.35/0.64	1.00/1.80
T	°C °F	0.23/0.41	0.26/0.46	0.46/0.82
E	°C °F	0.23/0.41	0.28/0.51	0.68/1.23
R	°C °F	0.38/0.68	0.67/1.20	1.37/2.46
S	°C °F	0.36/0.64	0.71/1.28	1.52/2.72
B	°C °F	0.44/0.79	0.72/1.29	1.32/2.38
Platinel II (AuPt/Pd)	°C °F	0.19/0.35	0.41/0.73	1.11/2.00
J-DIN	°C °F	0.21/0.38	0.26/0.47	0.57/1.03
T-DIN	°C °F	0.21/0.38	0.24/0.44	0.46/0.82
N (Nicrosil/Nisil)	°C °F	0.22/0.40	0.33/0.59	0.86/1.56
Temperature →	°C °F			

illivolt Functions

Voltage Range	Resolution	RSS Cal. Accuracy[3]	Overall Accuracy[4]
−9.998mV to +99.998mV	0.002mV	±0.012% of Reading + 0.004 mV	±0.035% of Reading + 0.008 mV

Notes

1. For thermocouple calibrated functions, the output range is −9.998mV to +99.998mV with resolution and accuracy per the corresponding temperatures shown. **2.** Data conformity to ANSI Spec MC 96.1-1975. NBS Monograph 161, DIN-43710, or manufacturers of Platinel II. **3.** RSS = the square root of the sum of the squares of all the error contributions involved at 25° ±2°C. **4.** Instrument RSS accuracy at 25°C ±10°C, after 1 year.

mportant User Features

Lightweight: less than 1.5 pounds (0.68 kg.)
Compact: 2″ (50mm) H x 5.5″ (140mm) W: x 3.75 D: (95 mm)
High NBS conformity: ±0.2°C
Rugged: high-impact plastic, splashproof case
Laboratory performance:
Accuracy: See chart above.
Resolution: 0.1°C or °F, 2μ V as indicator or simulator

- **Works anywhere:** NiCad batteries, continuous operation for up to 10 hours
- **Rechargeable:** from 110 or 220 V ac source
- **Computer based:** complete NBS calibration tables electronically built in
- **Powerful**
- Eleven thermocouple types available in every instrument with any two types and mV operating together
- Measures temperature directly in degrees C or F
- Supplies CJ compensated, thermocouple output for calibrating indicators, controllers, data loggers, and recorders
- Measures mV signals with μV resolution
- Supplies mV levels for other calibration tasks

CL6503
CAL
MEAS
FAST
HOLD
PEAK
°C/°F
T1
T2
°C
°F
2999.9
PEAK
BAT
CAL
mV
HOLD
OMEGA

Off-the-Shelf Delivery!

HOW TO ORDER

Ordering is as easy as 1-2-3

[1] Instruments are shipped configured to your specifications! Although 11 thermocouple typ are internally selectable—
Specify the two types to be active on rear pan switch. J—K—T—E—N—Platinel II—J-Din—T-Din—R—S—B

[2] **Specify** °C or °F. CL-6501 is dedicated either °C or °F. Th CL-6502 and CL-6503 are switchable between °C and °F they will, however, show a specified scale when turned o

[3] **Specify** line voltage for Battery Charger—110 V ac or 220 V ac.

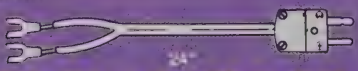
Code	Description	Pr
CL-6501-[1]-[1]-[2]-[3]	Dedicated thermometer for two thermocouple types, including NICAD battery pack, charger, neckstrap, TAS-K-2 adaptor, uncompensated connector, Type K beaded wire thermocouple with connector, vinyl case and instruction manual	$4
CL-6502-[1]-[1]-[2]-[3]	Same as above, except with controls for peak reading, °C/°F changes, hold function	5
CL-6503-[1]-[1]-[2]-[3]	Calibrator-thermometer. Same as CL-6502 plus a precision calibration source.	7
Accessories		
CL-6500-BAT	Extra NiCad battery pack.	2
CL-6500-CHAR-[ ]	Extra charger for NiCad battery pack. Specify 110 V ac or 220 V ac	2
RCC-6500	Deluxe snap closed case that permits instrument use without removal.	3
CL-6500-STND	Heavy steel stand with adjustable positioning for easy viewing. May be screwed to bench.	7

Hook-up Cables

Convenient pre-made cables make connections easy. Thermocouple type of cable and instrument to be calibrated must match. Specify cable option and thermocouple type for CL-6500 Calibrator.

Cable Option-A-[ ]-SMP-M **Adaptor Cable** $10
[T/C type]
J,K,T,E,R,S,B
U2 (Copper)

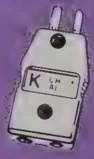
24" Thermocouple Alloy Hook-up Cable with SMP connector to mate with CL-6500 and compensated spade lugs for connections to test instrument.



FREE! Adaptor TAS-K-2

To make your CL-6500 even more versatile, a type K miniature-to-standard adaptor is supplied. Probe and Adaptor calibration must match.

Extra Adaptors
TAS-[ ]-2 $10
Specify calibration
J,K,T,E,R/S or U (Copper)



Patent Pending

Switch between either of two thermocouple types selected from 11 available types. Choose the two thermocouple types by changing internal jumper locations.

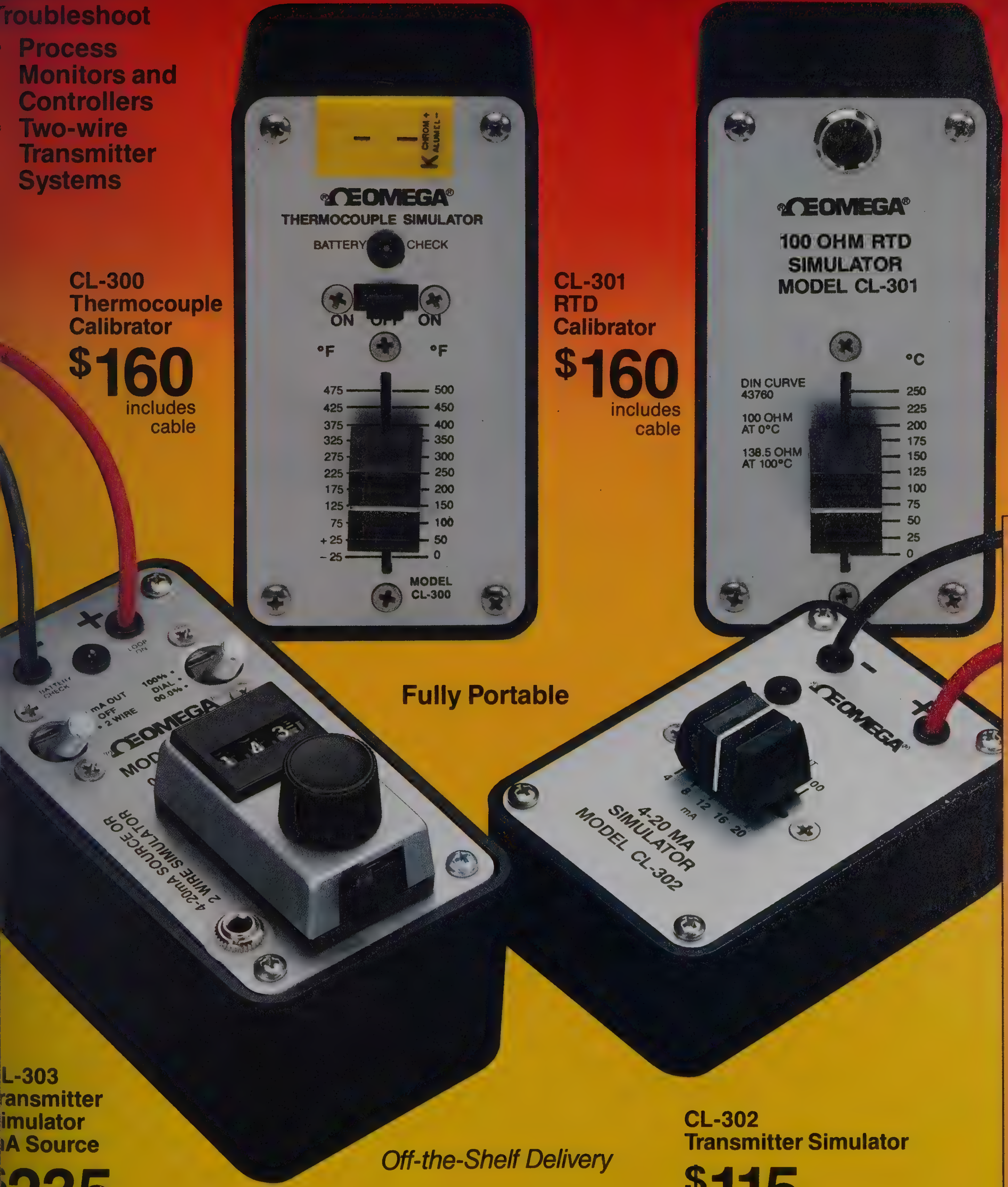
Jumper also chooses °C or °F when the unit is turned on. Subsequent changes may be made by front panel push button control on Models CL-6502 and CL-6503. Model CL-6501 has no external °C/°F control.

Internal Jumper Location	1	2	3	4	5	6	7	8	9	10	11	12
Condition Activated for External Control	TYPE J	TYPE K	TYPE T	TYPE E	TYPE N	PLATINEL II or III	TYPE J-DIN	TYPE T-DIN	TYPE R	TYPE S	TYPE B	°C*

* °F displayed initially if location 12 has no jumper

NEW! Affordable Calibrators
Series CL-300

Calibrate and
Troubleshoot
- Process Monitors and Controllers
- Two-wire Transmitter Systems


K CHROM + ALUMEL −
ΩEOMEGA®
THERMOCOUPLE SIMULATOR
BATTERY CHECK
ON OFF ON
°F °F
475 425 375 325 275 225 175 125 75 +25 −25
500 450 400 350 300 250 200 150 100 50 0
MODEL CL-300
ΩEOMEGA®
100 OHM RTD SIMULATOR MODEL CL-301
°C
DIN CURVE 43760
100 OHM AT 0°C
138.5 OHM AT 100°C
250 225 200 175 150 125 100 75 50 25 0
+ LOOP ON
BATTERY CHECK
mA OUT OFF 2 WIRE
100% DIAL 00.0%
ΩEOMEGA
2 WIRE SIMULATOR 4-20mA SOURCE OR
ΩEOMEGA®
4-20 MA SIMULATOR MODEL CL-302
4 8 12 16 20 mA
− +

CL-300
Thermocouple Calibrator
$160
includes cable

CL-301
RTD Calibrator
$160
includes cable

Fully Portable

L-303
ransmitter
imulator
A Source
235

Off-the-Shelf Delivery

CL-302
Transmitter Simulator
$115

OMEGA
THERMOCOUPLE SIMULATOR
BATTERY CHECK
ON OFF
°F
MODEL CL-300

$160
Cable Included

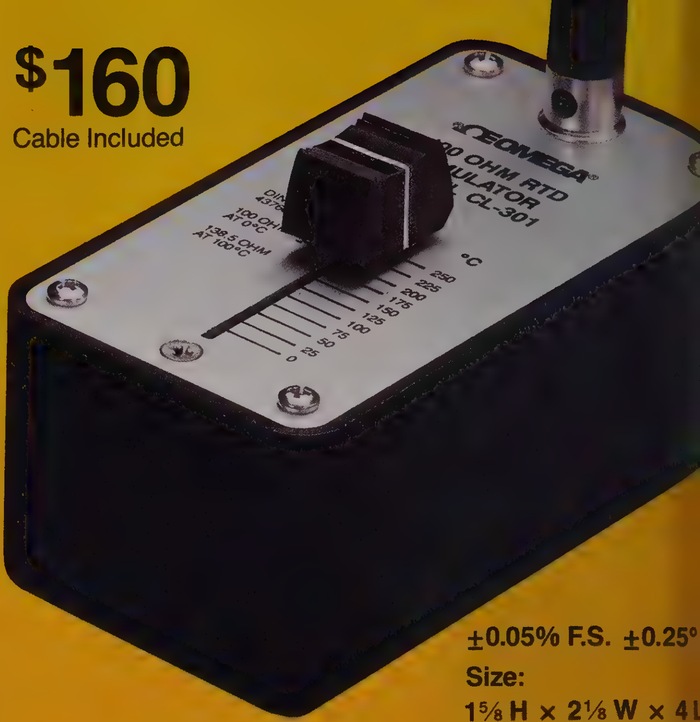
±0.1% F.S. ±1°
add ±2° below 0°

Size:
1⅝ H × 2⅛ W × 4 L

Model CL-300

Thermocouple Calibrator

- Simulates Thermocouples J, K, E, T, R, S, or mV Source
- 2 ft. of Standard Thermocouple Cable with male SMP Connector and Compensated Terminal Lugs
- Twenty-two Precise Test Points
- Portable, Long Battery Life



$160
Cable Included

±0.05% F.S. ±0.25°

Size:
1⅝ H × 2⅛ W × 4 L

Model CL-301

RTD Calibrator

- Calibrate and Troubleshoot 2, 3, or 4 wire RTD systems
- Simulates 100 ohm RTD, $\alpha = .00385$
- 2 ft. of 3 wire RTD Cable with a Series T Female Connector (which plugs into the unit) and Output Terminal Lugs

How To Order

Catalog No.	Temperature Range	Thermocouple Types	Temperature Divisions
CL-300- 500F-[*]	–25 to 500°F	J, K, T, E	25°
CL-300- 500C-[*]	–25 to 500°C	J, K, T, E	25°
CL-300-1000C-[*]	–50 to 1000°C	J, K, E	50°
CL-300-1000F-[*]	–50 to 1000°F	J, K, E	50°
CL-300-2100F-[*]	0 to 2100°F	J, K	100°
CL-300-3100F-[*]	1000 to 3100°F	R, S	100°
CL-300-1700C-[*]	650 to 1700°C	R, S	50°
CL-300-100 mV	–5 to 100.0 mV		5 mV

**Insert thermocouple type*

CABLE OPTIONS

with male SMP connector and compensated terminal lugs.

Standard Cable	Price	Retractable Cable	Price
CL-300-CABLE-[ ]-[ ]		CL-300-RSC-[ ]-[ ]	
thermocouple type		thermocouple type	
length in feet		specify 1, 2, 3, or 4 feet	
up to 2 feet	$9.80	first foot	$15.50
each add'l. foot	$1.40	each add'l. foot	$ 5.00

1 ft. of retractable cable expands to 5 ft.

Ordering Example:

1. CL-300-500F-K; CL-300 calibrator for type K instruments, range of –25 to 500°F	$160.00
2. CL-300-RSC-K-2 ft.; 2 ft. of type K retractable cable	$ 20.50
3. SC-300; soft carrying case	$ 10.00
	$190.50

Catalog No.	Temperature Range	Temperature Divisions
CL-301- 250F	0 to 250°F	25°
CL-301- 250C	0 to 250°C	25°
CL-301- 500F	0 to 500°F	50°
CL-301- 500C	0 to 500°C	50°
CL-301-1000F	0 to 1000°F	100°

CABLE OPTIONS

Standard Cable*	Price	Retractable Cable	Price
CL-301-CABLE-[ ]		CL-301-RSC-[ ]	
length in feet		specify 1, 2, 3, or 4 feet	
first 2 feet	$15.50	first foot	$18.25
each add'l. foot	$ 2.25	each add'l. foot	$ 4.00

Standard is 3-wire cable with T-Series connector and spade lugs. 2- and 4-wire cables also available. Consult Sales Department.

Ordering Example:

1. CL-301-250F; CL-301 range 0 to 250°F, with cable	$160.00
2. CL-301-RSC-2 ft.; additional cable, 2 ft. of 3-wire retractable RTD wire.	$ 22.25
3. SC-300; soft carrying case	$ 10.00
	$192.25

$115
Cable attached

0.1% F.S.

ize:
⅛ H × 2 W × 3⅛ L

Model CL-302

Transmitter Simulator

- Calibrate or Test 4-20 mA Systems
- Simulates Loop Powered Transmitters
- Five Precise Test Points
- Portable with 0.1% Accuracy

$235
Batteries
Included

±0.1% F.S.

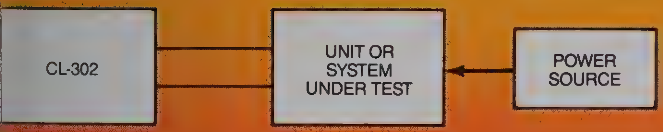
Size:
2½ H × 2⅛ W × 4 L

Model CL-303

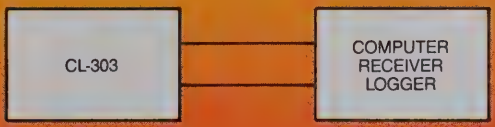
mA Source
Transmitter Simulator

- Calibrate or Test 4-20 mA dc System
- Precise 4-20 mA dc Source
- Simulates Loop Powered Transmitter
- Continuous Settings 0 to 100%
- Quick Check Switch 0% or 100%

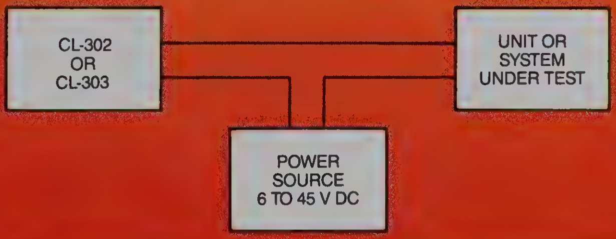
AS A 2-WIRE SIMULATOR
WITH SELF POWERED UNIT


CL-302
UNIT OR SYSTEM UNDER TEST
POWER SOURCE

AS A 4-20 mA SOURCE


CL-303
COMPUTER RECEIVER LOGGER

AS A 2-WIRE SIMULATOR
WITH EXTERNAL POWER

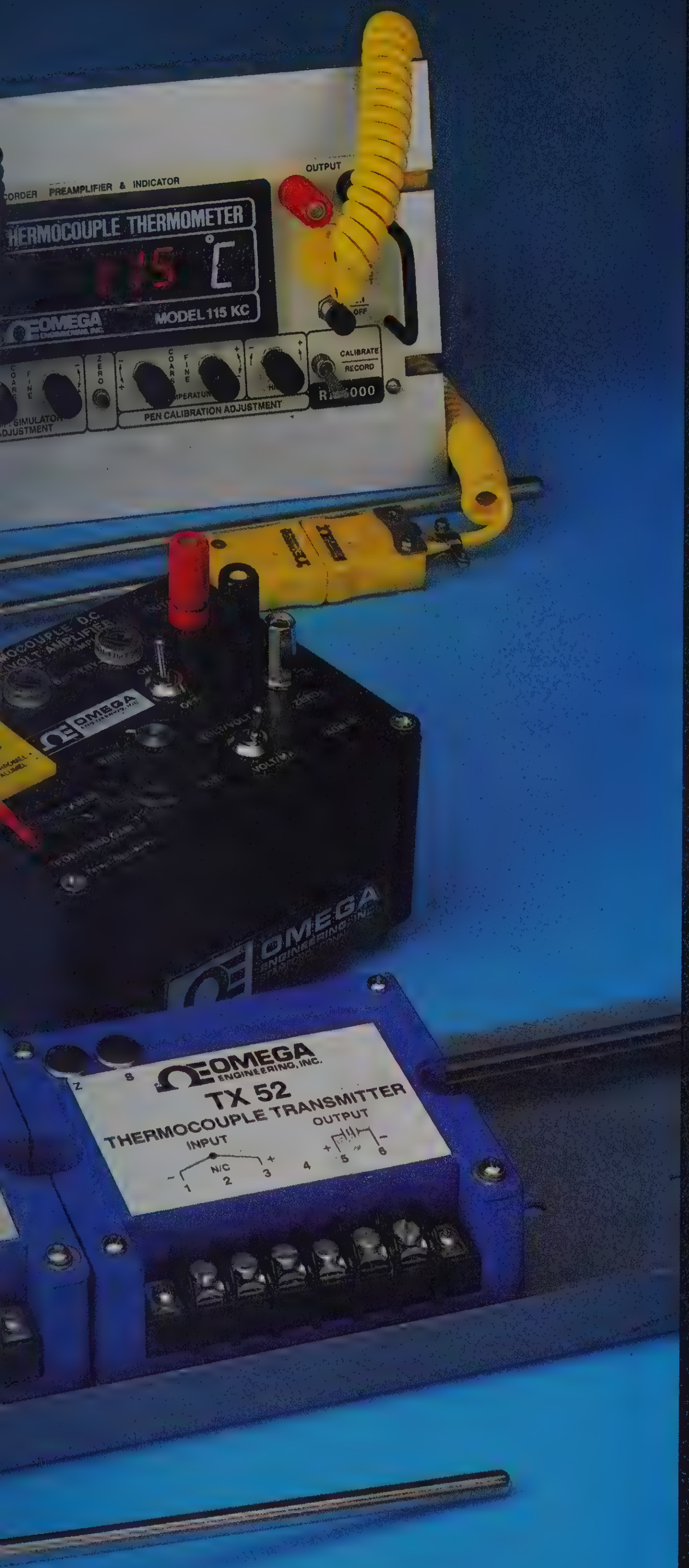

CL-302 OR CL-303
UNIT OR SYSTEM UNDER TEST
POWER SOURCE 6 TO 45 V DC

Order CL-302 $115

Order CL-303 $235

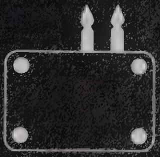
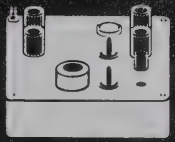
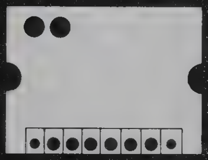
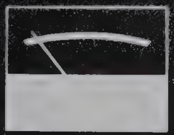
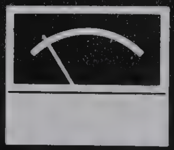
Accessories		CL-300	CL-301	CL-302	CL-303
SC-300 Carrying Case with zipper	$10	✓	✓	✓	✓
MN-1500-2 Pair of AA alkaline batteries	1	✓	—	—	—
MN-1604 9 V alkaline battery	3	—	—	—	✓
CL-303-AC AC adaptor	20	—	—	—	✓

T/C RECORDER PREAMPLIFIER & INDICATOR
THERMOCOUPLE THERMOMETER
MODEL 115 KF
OUTPUT
ON
OFF
CALIBRATE
RECORD
THERMOCOUPLE THERMOMETER
OMEGA ENGINEERING, INC.
MODEL 115
°F
°C
0°F
0°C
+ 81.0
OMEGA
OMEGA ENGINEERING, INC.
One Omega Drive
Stamford, CT 06907
(203) 322-1666
ON
OMEGA ENGINEERING, INC.
TX53
THERMOCOUPLE TRANSMITTER
INPUT
OUTPUT
N/C
Z
S
OMEGA ENGINEERING, INC.
TX58
RTD TRANSMITTER
INPUT
OUTPUT

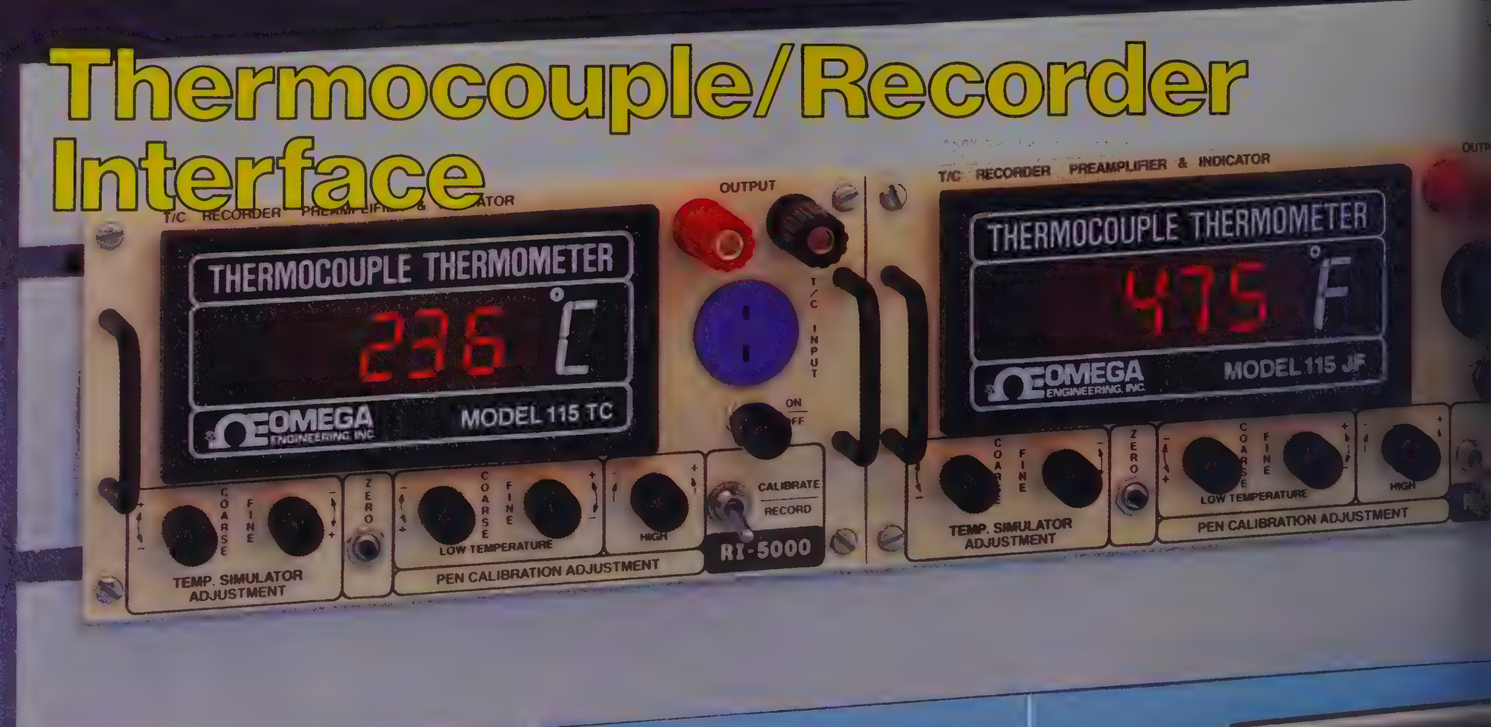

PREAMPLIFIER & INDICATOR
OUTPUT
THERMOCOUPLE THERMOMETER
115 °C
OMEGA
MODEL 115 KC
CALIBRATE
RECORD
PEN CALIBRATION ADJUSTMENT
OMEGA ENGINEERING, INC.
TX 52
THERMOCOUPLE TRANSMITTER
INPUT
OUTPUT
N/C

L

Transmitters, Amplifiers and Analog Meters

NEW RI-5000 Thermocouple Preamplifier, Linearizer and Transmitter with Digital Readout		L-3
NEW TAC 386 Thermocouple to Analog Converter		L-5
OMNI-AMP™ II Thermocouple Amplifiers		L-6
OMNI-AMP™ Thermocouple Amplifiers		L-7
NEW Super CJ™ Cold Junction Compensator, Linearizer and Amplifier		L-8
NEW Two Wire Transmitters for Thermocouples and RTD's		L-9
NEW TX-81 Industrial Current Loop Indicator		L-13
Series 4000 Analog Pyrometers		L-16
Series 7000 Analog Pyrometers		L-19

Thermocouple/Recorder Interface


T/C RECORDER PREAMPLIFIER & INDICATOR
THERMOCOUPLE THERMOMETER
236 °C
OMEGA ENGINEERING INC
MODEL 115 TC
OUTPUT
T/C INPUT
ON
OFF
CALIBRATE
RECORD
RI-5000
COARSE
FINE
ZERO
TEMP. SIMULATOR ADJUSTMENT
LOW TEMPERATURE
HIGH
PEN CALIBRATION ADJUSTMENT
475 °F
MODEL 115 JF

OMEGA®
Model 595 Recorder Shown

Probes and wire not included

Bench Style RI-5100

The RI-5100 Models have a fully enclosed metal case with a hard polyurethane finish to withstand being "knocked" around on a workbench. They are available in ONE, TWO, or THREE channels and are designed to work side-by-side with your recorder to take up a minimum of bench top space.

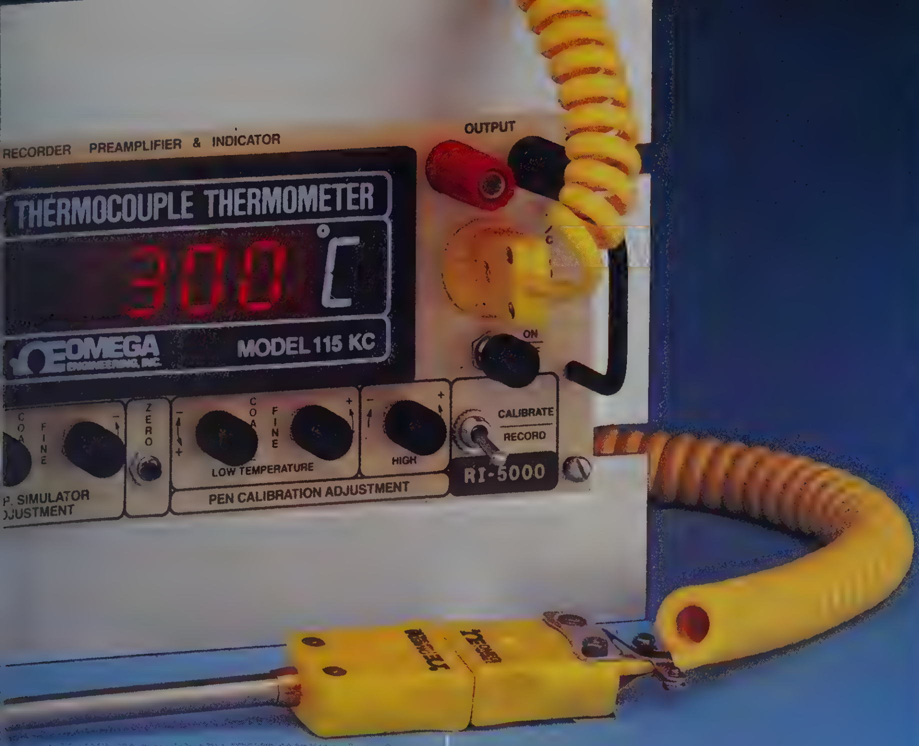
Mix and Match—put three different calibrations or any combinations in a single box to cover all your measurement/recording needs. No extra bench space is required! Series RI-5100 Thermocouple to Recorder Interfaces are available in J, K, T and E Thermocouple Calibrations. (See Range Table at right for ranges.)

THREE CHANNELS

$1100

Model RI-5103
Bench Style

For Additional Specifications See Recorders, Section N.



Probes and wire not included

Panel Style RI-5000

The RI-5000 Panel is completely modular. It is available with up to three modules fully assembled into a standard 19 inch rack panel, or separately, in a 3 inch by 6 inch panel to fit your custom design.

Mix and Match—put three different calibrations or any combination into a single 19″ panel to cover all your measurement/recording needs. No extra panel space is required! Series RI-5000 Modules are available in J, K, T and E Thermocouple Calibrations. (See Range Table below for ranges.)

THREE CHANNELS

$995

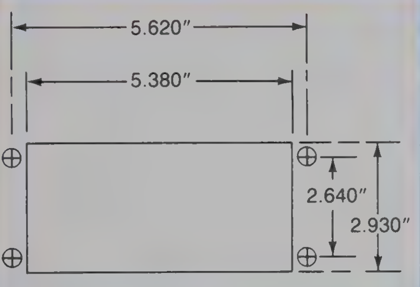
Includes 3 RI-5000 Modules and a 19 inch Panel

ecord Temperature ompensate—Amplify—Linearize—Calibrate

ries RI-5000 instruments make it easy. They take a thermocouple signal, d cold junction compensation, amplify it, linearize it and output a 1 mV/°C gnal to your recorder.

ese units also have a built-in calibrator to assist in setting up the recorder's ales and a zero offset circuit to set up a precise range. The bipolar output ows you to record positive as well as negative temperatures accurately d the two styles—Panel and Bench Top—meet most laboratory and dustrial applications.

Cut Out Dimensions RI-5000



ange Table

rder Code	ANSI Type	Temperature Range	Linearized Output	Accuracy	Display Resolution
JC JF	J	−100 to 760°C −100 to 1400°F	1 mV/°C .55 m/°F	±2.5°C ±4°F	1°C 1°F
KC KF	K	−50 to 1200°C −50 to 1999°F	1 mV/°C .55 mV/°F	±3.5°C ±5°F	1°C 1°F
TC TF	T	−100 to 400°C −100 to 750°F	1 mV/°C .55 mV/°F	±2.5°C ±4°F	1°C 1°F
EC EF	E	−50 to 800°C −50 to 1500°F	1 mV/°C .55 mV/°F	±3.5°C ±5°F	1°C 1°F

pecifications

MODEL	HEIGHT	WIDTH	DEPTH	WEIGHT
RI-5000	3″	6″	5.5″ *	1.25 lb
RI-5101	6	6.25	5.5	2.75
RI-5102	6	6.25	8.5	4.25
RI-5103	6	6.25	11.5	5.75
9″ Panels	5¼″	19″	.125″	—

I-5000 requires only 4.5 in. clearance behind panel

How To Order *Off-the-Shelf Delivery*

Description	Catalog No.	Price
Rack Mountable Models	RI-5000-[*]	$ 320
19″ Rack Models	RI-5000-[*]-19P1	$ 355
	RI-5000-[*]-[*]-19P2	$ 675
	RI-5000-[*]-[*]-[*]-19P3	$ 995
Bench Top Models		
One Channel	RI-5101-[*]	$ 395
Two Channel	RI-5102-[*]-[*]	$ 750
Three Channel	RI-5103-[*]-[*]-[*]	$1100
Power Options:	Specify after Catalog Number	
	230 V ac (115 V ac, std)	N/C
	50 Hz (60 Hz, std)	N/C

*Insert Order Code From Range Table

Ordering Examples:

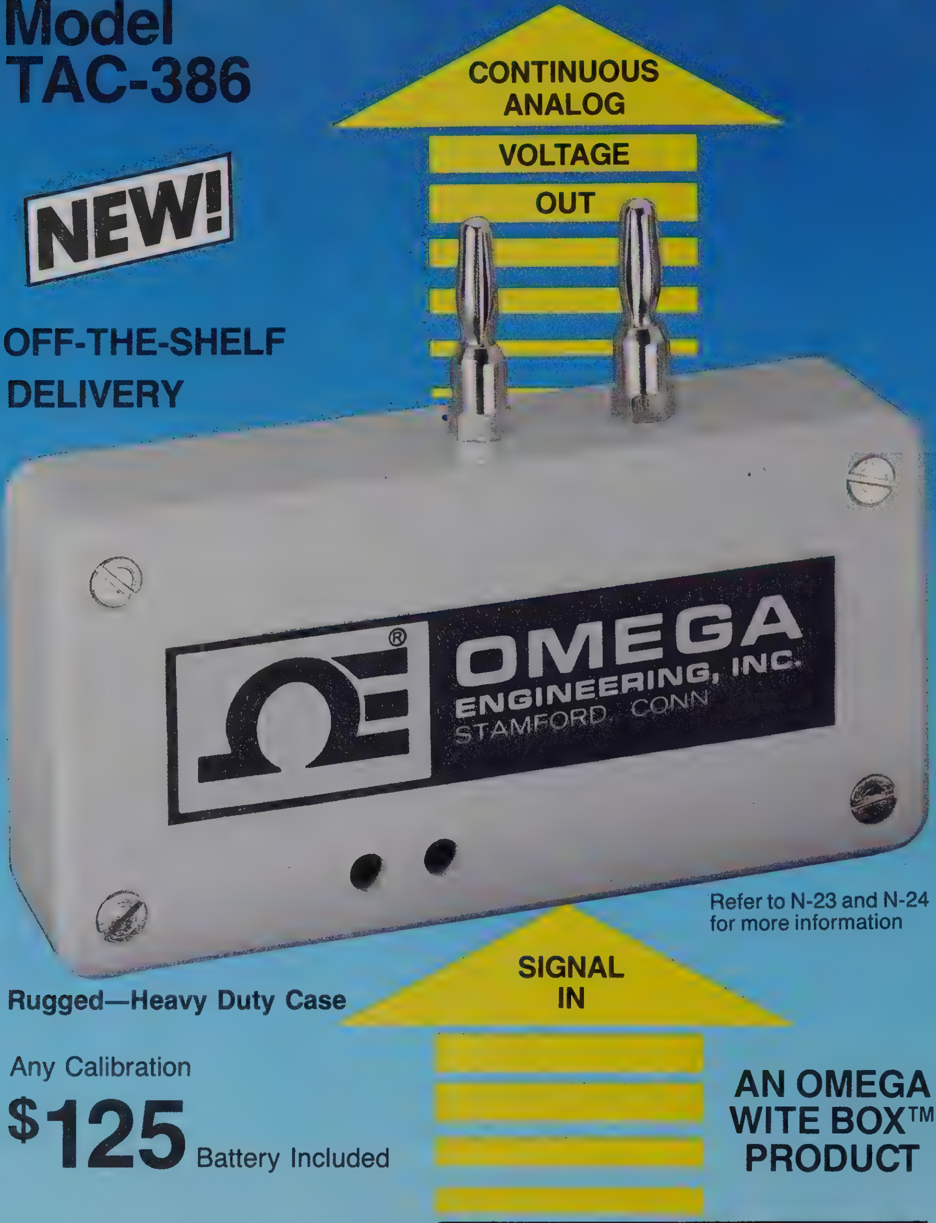
RI-5000-JC-KC-19P2	19″ Panel Style with two Model RI-5000s, one Type J and one Type K, fully assembled into a 19″ rack panel.	$675
RI-5103-[JC]-[JC]-[TF]-230	Bench Style Case with three channels, two Type J and one Type T, wired to operate from 230 V ac.	$1100

Thermocouple to Analog Converter

Model TAC-386

NEW!

OFF-THE-SHELF DELIVERY


CONTINUOUS ANALOG VOLTAGE OUT
OMEGA ENGINEERING, INC. STAMFORD, CONN
SIGNAL IN

Refer to N-23 and N-24 for more information

Rugged—Heavy Duty Case

Any Calibration

$125 Battery Included

AN OMEGA WITE BOX™ PRODUCT

Convert any Millivolt Recorder or Meter to Read Temperature

The OMEGA TAC-386 can turn any chart recorder or analog or digital voltmeter into an accurate wide-range temperature measuring instrument. The TAC-386 is a universal thermocouple amplifier and linearizer which provides a precision 1mV/°C signal for the popular J, K, or T thermocouples. Cold junction compensation is standard.

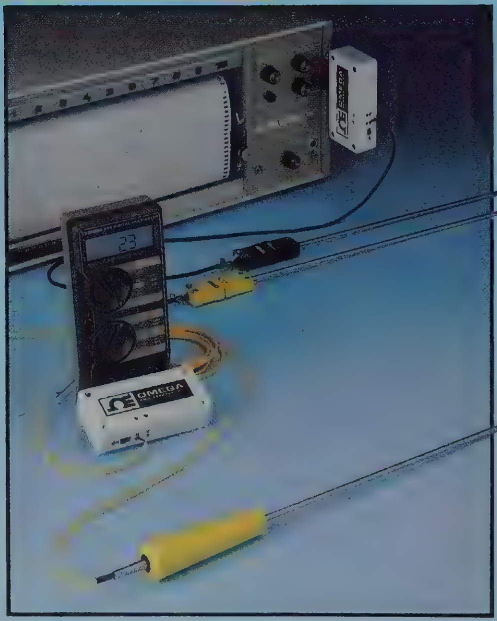
Easy-to-Use

Set instrument to 200mV range for readings of less than 200°C. Set instrument to 2V range for readings above 200°C. Your multimeter will read out directly in temperature—just transpose mV or V to °C.

- **Linearized and Compensated to 1 mV/°C**
- **Accurate**
- **Lo Power**
- **Accepts Miniature and Subminiature Connectors**

SPECIFICATIONS

Ranges: J −105° to 750°C
K −20° to 1200°C
T −86° to 350°C
Power: 9 V Alkaline Battery—MN1604
Accuracy: ±4°C over entire range
Response Time: 2 to 3 seconds
Reference Junction Stability: .05°C/°C
Input Conn.: Miniature Jack
Output Conn.: Std. Banana Jack ¾″ Spacing (19 mm)
Operating Temp.: 0° to 50°C
Storage Temp.: 0° to 65°C
Dimensions: W: 2½″ D: 3″ H: 2″



TO ORDER Specify Model:

Model	**TAC-386-J** Type J T/C −105° to +750°C	$12
Model	**TAC-386-K** Type K T/C −20° to +1200°C	$12
Model	**TAC-386-T** Type T T/C −86° to +350°C	$12
	MN 1604 Replacement Battery	$

See Section D for matching thermocouple probes

D.C. MILLIVOLT AMPLIFIER
OMEGA
ON
OFF
OUT
ZERO
ADJUST
VOLT/MA
GAIN
100
FULL CLOCKWISE
FOR FIXED GAIN
PATENT APPLIED FOR
OMEGA ENGINEERING, INC. STAMFORD, CONN.

Omni-Amp IIA

Battery-Operated Laboratory Model

$175

- Heavy-duty case
- Batteries will last over 500 hours in continuous service. (Spare set of batteries $4)
- Mallory MN 1400 or equivalent
- Specifications and performance characteristics the same as Model OMNI-AMP I.

COLD JUNCTION COMPENSATION

THERMOCOUPLE D.C. MILLIVOLT AMPLIFIER
REFERENCE
BATTERY
AMPLIFIER
OMEGA
OUT
OFF
ZERO
ADJUST
VOLT/MA
GAIN
100
FULL CLOCKWISE
FOR FIXED GAIN
Patent Applied for
K CHROMEL + ALUMEL −
OMEGA ENGINEERING, INC. STAMFORD, CONN.

Omni-Amp IIB

Battery-Operated Laboratory Model with Built-in Ice Point Reference Junction

$240

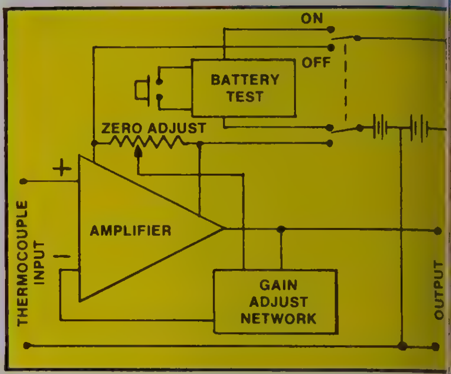
- Heavy-duty case
- Batteries will last over 500 hours in continuous service. (Spare set of batteries $7)
- Mallory MN 1400 or equivalent
- Eveready EI2N or equivalent
- Other specifications and performance characteristics the same as Model OMNI-AMP I.
- Select any calibration desired — either K, J, T, E, S, R, G, C or D from page K-12 of this catalog and add as a suffix to model number.

THERMOCOUPLE
— AMPLIFIER —
INPUT
OUTPUT
OMEGA
ENGINEERING, INC.
STAMFORD, CONN.
GAIN
ZERO
BATTERY
VARIABLE

Jumper Jack:
ENABLES OMNI-AMP I
TO BE PLUGGED INTO
ANY READOUT DEVICE

THERMOCOUPLE AMPLIFIER OMNI-AM

CIRCUIT:



$145

comes complete with connectors, jumpers and batteries

Spare set of 4 batteries $12

to order:
simply specify
OMNI-AMP I

WHAT IS IT?:

OMEGA'S portable thermocouple signal amplifier is designed to **multiply small voltage signals.** The output can be used directly by most readouts, such as panel meters, strip chart and x-y recorders, multimeters, multiplexers, and for input to control systems.

Minute thermocouple output **signals** can be **multiplied** up to **100 times** to drive meters or instruments which otherwise are not sensitive enough to be driven directly by the small output voltage of a thermocouple.

This small, compact, completely self-contained high gain amplifier can be **instantly employed** in a thermocouple circuit either **at the thermocouple** or **at the readout device** having 1000 ohms or greater input impedance.

WHERE IT IS USED:

This small and powerful amplifier can be used with all thermocouple alloy combinations to boost output voltage. It can be placed directly at the thermocouple element output quick-disconnect jack (See Figures 2, 3 and 5) or anywhere in the circuit between the thermocouple and the readout device. **It is intended primarily for use with inexpensive moving coil meter devices.**

Where cold junction compensation is required, the
plifier can be plugged directly into an OMEGA CJ (C
Junction Compensator) which is housed in a sim
companion package (see Fig. 1). Also see Section
this catalog for more details on reference and
junction compensators used with this amplifier.
amplifier is available in a laboratory version with bui
ice point compensation.

The amplifier is also designed to be used where ther
couple meter or pyrometer input impedance limits
thermocouple lead length or total circuit resistance
thermocouple system. For example, many thermocou
readout meters or pyrometers require that the ther
couple circuit impedance be 10 ohms or less
matched to the meter. With this **amplifier** in the cir
set at **unity gain,** the input resistance of the thermoc
ple circuit is virtually independent of the readout dev
Thus, with a one to one amplification setting, ther
couple **leads up to ¼ mile long** can be used where
viously only short lead lengths were tolerated. Also,
fine gage thermocouples having fast response but
resistance **can** now **be used** with great ease.

SPECIFICATIONS

Gain:	Choice of seven fixed gains: 1, 2, 5, 10, 25, 50 or 100 V/V, settable by means of an externally accessible rotary selector switch. In addition, an eighth switch position connects a self-contained potentiometer for continuously variable gains between 5 and 100 V/V.
Input impedance:	One (1) megohm for any gain setting.
Frequency response:	DC to 100 Hz at a gain setting of 100 with higher frequency response at lower gain settings.
Output:	− ⅝ to + 1¼ VDC into 1000 ohm (or greater) load. (Matches every thermoelectric curve).
Noise:	Equivalent noise input, 5 microvolts RMS (equals 500 microvolts RMS output at 100 gain setting).

Zeroing:	Output may be offset up to ±1⁄1 all gain settings except unity. O AMP is factory-zeroed at unity
Temperature coefficient:	±5 microvolts/°F as seen at i from 30 to 65°F ±3 microvolts/°F as seen at i from 65 to 100°F
Battery life:	100 hours or more at maximum put (72°F ambient).
Battery test:	Light emitting diode will glow t dicate good batteries when test ton is pressed.
Batteries: (included) (Spare batteries $12 per set)	Use four (4) PX625B.
Size and Weight:	¾″ x 1¾″ x 5¼″ 8 oz.

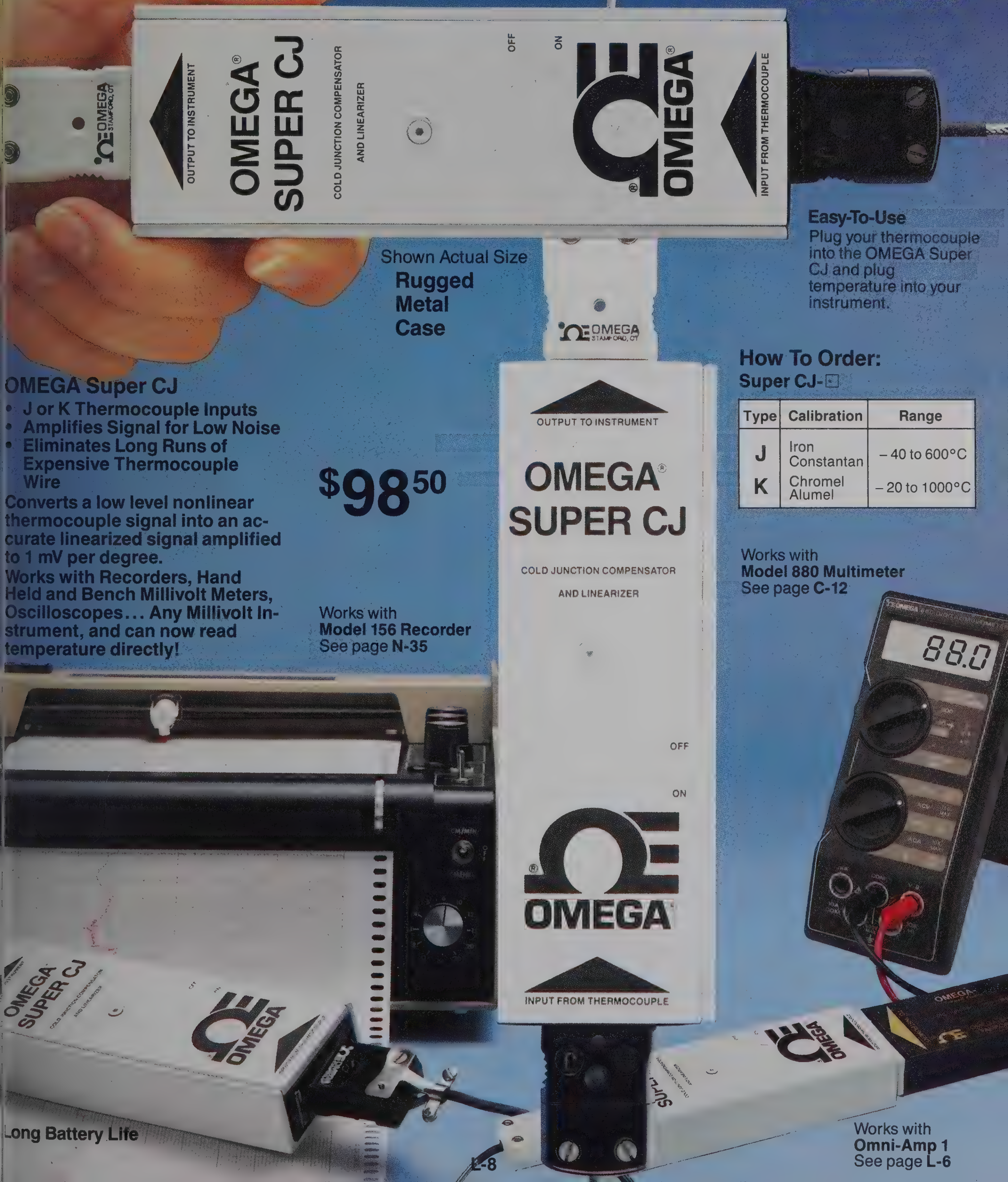
FEATURES:

Stability:	Assured through use of precision metal film resistors, integrated circuits and gold contact switching.
Feedback gain control:	Stability and accuracy are not compromised by the use of an input attenuator.

Output:	May be short circuited without d age.
Input:	Overloads up to ± 2½ V can be t ated without damage.

Comes complete with quick disconnect male plug,
nana jack adaptor and mercury batteries.

Thermocouple Amplifier
Cold Junction Compensator and Linearizer


OUTPUT TO INSTRUMENT
OMEGA® SUPER CJ
COLD JUNCTION COMPENSATOR AND LINEARIZER
OFF
ON
OMEGA®
INPUT FROM THERMOCOUPLE
OMEGA STAMFORD, CT
88.0

Easy-To-Use
Plug your thermocouple into the OMEGA Super CJ and plug temperature into your instrument.

Shown Actual Size

Rugged Metal Case

How To Order:
Super CJ-☐

Type	Calibration	Range
J	Iron Constantan	– 40 to 600°C
K	Chromel Alumel	– 20 to 1000°C

OMEGA Super CJ
- **J or K Thermocouple Inputs**
- **Amplifies Signal for Low Noise**
- **Eliminates Long Runs of Expensive Thermocouple Wire**

Converts a low level nonlinear thermocouple signal into an accurate linearized signal amplified to 1 mV per degree.

Works with Recorders, Hand Held and Bench Millivolt Meters, Oscilloscopes… Any Millivolt Instrument, and can now read temperature directly!

$98.50

Works with
Model 156 Recorder
See page **N-35**

Works with
Model 880 Multimeter
See page **C-12**

Long Battery Life

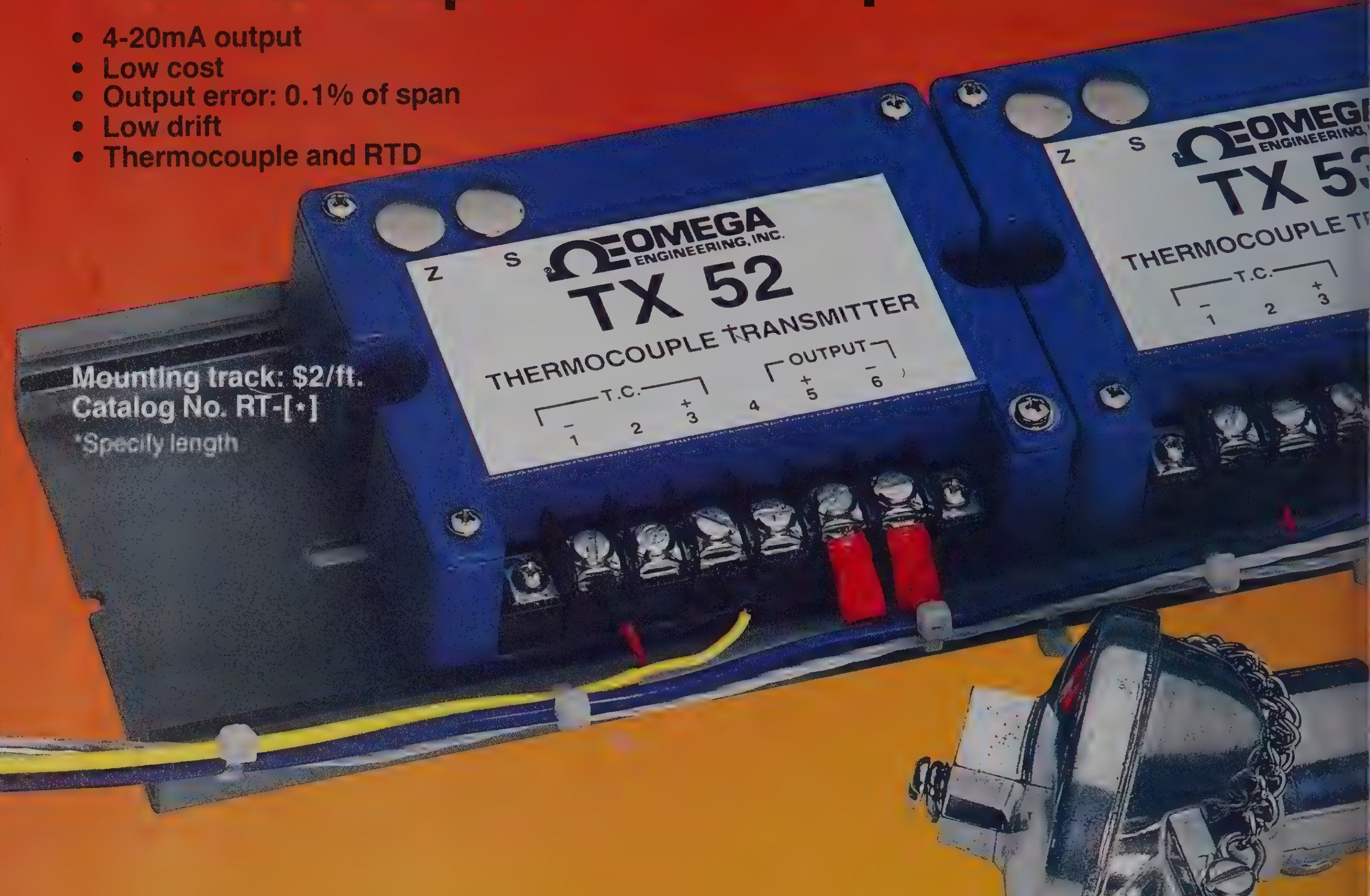
Works with
Omni-Amp 1
See page **L-6**

2 Wire Transmitter

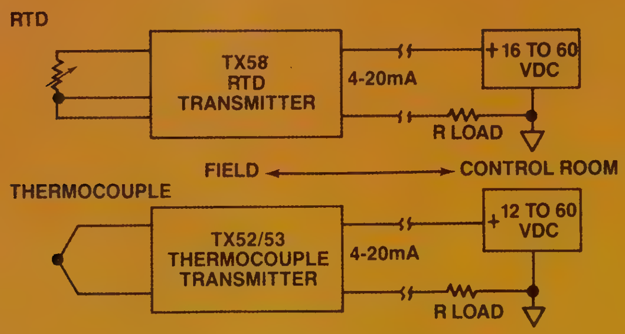
NEW!

Thermocouple or RTD Input

- 4-20mA output
- Low cost
- Output error: 0.1% of span
- Low drift
- Thermocouple and RTD


Z
S
OMEGA ENGINEERING, INC.
TX 52
THERMOCOUPLE TRANSMITTER
T.C.
−
1
2
+
3
4
OUTPUT
+
5
−
6
TX 53
THERMOCOUPLE TR

Mounting track: $2/ft.
Catalog No. RT-[*]
*Specify length


RTD
TX58
RTD
TRANSMITTER
4-20mA
+16 TO 60
VDC
R LOAD
FIELD
CONTROL ROOM
THERMOCOUPLE
TX52/53
THERMOCOUPLE
TRANSMITTER
4-20mA
+
12 TO 60
VDC
R LOAD

From
$160

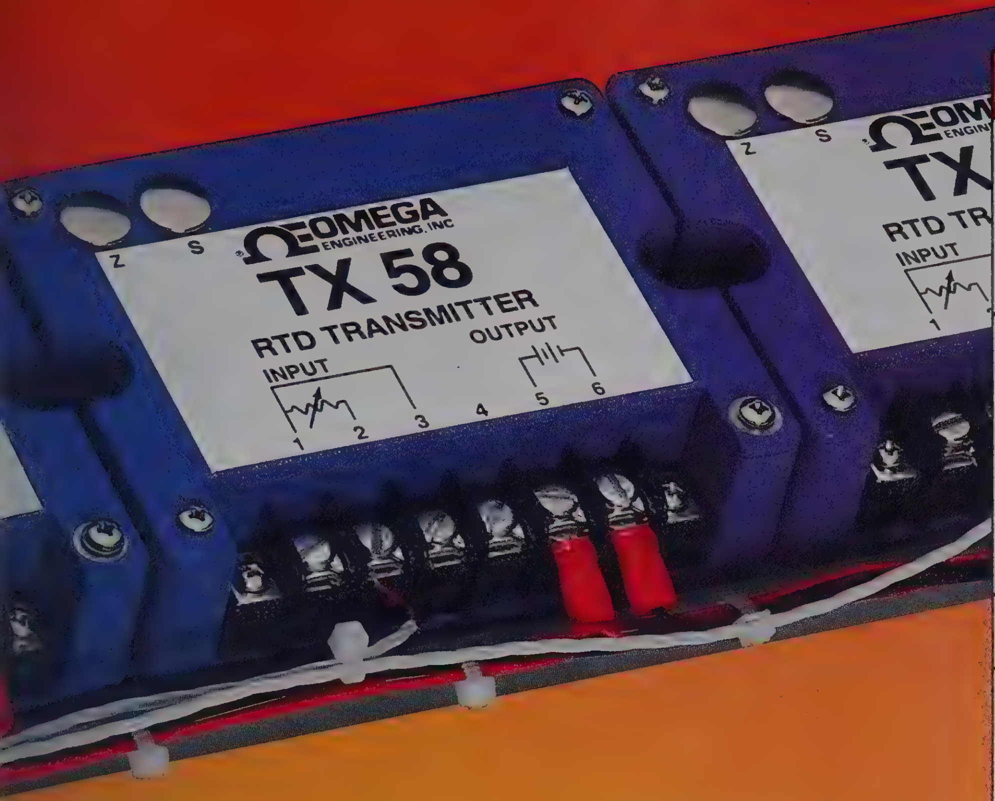
Transmitters provide a two-wire output with the same wiring used for power and output. The load resistance is connected in series with a dc power supply, and the current drawn from the supply is the 4-20mA output signal which is proportional to the measured temperature.

Two-wire current transmission permits remote mounting of the transmitter near the sensor to minimize the effects of noise and signal degradation to which low level sensor outputs are susceptible.

A rugged metal enclosure, suitable for field mounting, offers environmental protection and screw terminal input and output connections. This enclosure may be either surface or standard relay track mounted.

- **Thermocouples**
  OMEGA models TX52 and TX53 are high performance, low cost temperature transmitters designed to accept a thermocouple input from types J, K or T and produce a standard 4-20mA output current proportional to the measured temperature. The TX52 features high input to output isolation (600 rms) and high CMR (160dB @ 60 The TX53 offers a functionally equivalent design without input to output isolation.

- **Platinum RTD**
  Model TX58 accepts 2-wire or 3-wire 100Ω platinum resistance sensors (α = 0.00385 Ω/Ω/°C) and provides a linearized output.



Rugged Metal Case

In Stock for Immediate Delivery

RANGES AVAILABLE

Sensor Type	Range Code	Input Ranges	
"T" Thermocouple (Copper-Constantan)	T1 T2	−100°C to + 300°C 0°C to + 200°C	−148 to + 572°F + 32 to + 392°F
"J" Thermocouple (Iron-Constantan)	J1 J2 J3	0°C to + 500°C −100°C to + 300°C 0°C to + 750°C	+ 32 to + 932°F −148 to + 572°F + 32 to + 1382°F
"K" Thermocouple (Chromel-Alumel)	K1 K2 K3	−100°C to + 300°C 0°C to + 600°C 0°C to + 1000°C	−148 to + 572°F + 32 to + 1112°F + 32 to + 1832°F
Platinum 100Ω RTD (α = 0.00385)	Pt1 Pt2 Pt3 Pt4	−100°C to + 100°C 0°C to + 100°C 0°C to + 200°C 0°C to + 400°C	−148 to + 212°F + 32 to + 212°F + 32 to + 392°F + 32 to + 752°F

How to Order

Isolated (Input to Output) Thermocouple Range **TX-52-[*]**	**$225**
Non-isolated Thermocouple Range **TX-53-[*]**	**$160**
Platinum RTD Range—non-isolated **TX-58-[*]**	**$175**

**Insert Range Code*

Specifications

Output Specifications

Output Span	4-20mA
Minimum Output Current	3.5mA, typ
Maximum Output Current	40mA, typ
Output Protection[1]	±60V

Accuracy

Total Output Error[2]	±0.1%
Stability vs. Ambient Temperature	
Zero	°C/°C max
Span	±0.005%/°C
Stability vs. Time[2]	±50ppm/Month
Warm-up Time to Rated Performance	3 Minutes

Response Time

To 90% of Span	0.4 sec

Environmental

Temperature Range, Rated Performance	−30°C to +85°C
Storage Temperature Range	−55°C to +125°C
Relative Humidity, Non-condensing	0 to 90%
RFI Effect (5W @ 470MHz @3 ft.) Error	±0.5% of Span

Physical

Case Size	4″ × 3.25″ × 1.25″
Weight	8 oz. (227 grams)

NOTES

[1] Protected for reverse polarity and for any input/output connection combination

[2] Accuracy is specified as a percent of output span (16mA). Accuracy spec includes combined effects of transmitter repeatability, hysteresis and linearity. Does not include sensor error.

Complete Your System Model TX-81 4-20 mA Loop Display

$229

See page L-13 for complete details.

1999
PROCESS INDICATOR
TX-81
OMEGA
ENGINEERING, INC.

OMEGA® 2-Wire Transmitters

...will eliminate lengthy thermocouple extension leads in long runs. Use copper extension wire with our 2-Wire Transmitters. OMEGA also has power supplies for use with Transmitters.

General Specifications

Specifications for Thermocouple Models

Thermocouple types:
J, K, T, R, S, E, B, G, C.

Maximum Zero Offset Range:
– 10 mV to 25 mV.

Minimum Input Span:
5 mV

Minimum Input Impedance:
5 megohms.

Maximum Thermocouple Current: (includes Burnout Detection Current)
150 nanoamps.

Maximum Leadwire Resistance Effect:
0.15 microvolts per ohm of T/C resistance.

Burnout Protection:
Upscale

Accuracy (Combined Effects of Linearity, Hysteresis, & Repeatability):
0.1% of span maximum error.

Linearity (Referenced to Linearity of Input):
0.05% of span maximum error.

Specifications for RTD Models

Input
100 Platinum RTD

Minimum Input Span
10 ohms

Maximum Excitations Current 4mA.

Maximum Leadwire-Resistance Effect
1% of span error with up to 40 ohms per lead.

Accuracy (Temperature Conformity, or Linearizing Accuracy)
Typical Error: 0.1% of temperature span.
Maximum error: 0.25% of temperature span.

Output Span
4-20mA (Option A for 10-50mA).

Minimum Current
3.3mA, typical.

Maximum Output Current
Isolating Versions: 25mA, typical.
Non-isolating Versions: 40mA, typical.

Supply Voltage Range
12V to 90V T/C. 16V to 90V RTD.

Maximum Change-in-Supply-Voltage Effect
0.05% of span error.

Maximum Change-in-Load Effect
0.05% of span error.

Turn On Time
2 seconds.

Maximum Response Time
250 milliseconds.

Maximum Ripple
0.1% of span rms.

Ambient Temperature Range
–40°C to 80°C.

Stability with Temperature
Maximum Zero Drift: 0.025 of span per degree C, or 1 microvolt, whichever is greater.
Maximum Span Drift: 0.01% of span per degree C.

Maximum Reference Junction Error (T/C Models)
For Ambient 0°C to 80°C: 1 degree C.
For Ambient –40°C to 0°C: 4 degrees C.

Maximum RFI Effect (5W at 470MHz at 3 ft)
1% of span error.

Isolating Limit (For isolating versions only)
600V DC or peak AC between input and output.

Minimum Common-Mode Rejection (for isolating versions only)
120dB (DC to 400 Hz).

Available Ranges for 2-Wire Transmitters

	J	K	T	R&S	RTD
–250 to 0°C (–418 to 32°F)			X		
–100 to 100°C (–148 to 212°F)		X	X		X
–100 to 300°C (–148 to 572°F)	X	X	X		
0 to 200°C (32 to 392°F)	X	X	X		X
0 to 400°C (32 to 752°F)	X	X	X		X
0 to 600°C (32 to 1112°F)	X	X			X
0 to 800°C (32 to 1472°F)	X	X		X	
0 to 1000°C (32 to 1832°F)	X	X		X	
0 to 1200°C (32 to 2192°F)		X		X	
0 to 1500°C (32 to 2732°F)				X	
0 to 1700°C (32 to 3092°F)				X	

OTHER THERMOCOUPLE TYPES AND RANGES AVAILABLE. PLEASE CONSULT FACTORY.

Ordering Information

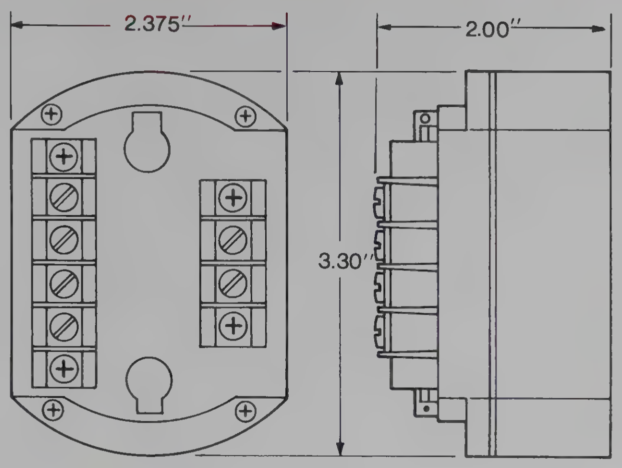
Isolated Versions: Probe is isolated from transmitter loop to avoid ground loop errors.

2 WTXI-	☐	-	☐	-	☐	**$325**
	Lower range unit in °C or °F		Thermocouple type		Upper range limit in °C or °F	
2 WTXI-	☐	-	RTD	-	☐	**$325**

Non-Isolated Versions: For use with single loop applications or ungrounded probes.

2 WTX-	☐	-	☐	-	☐	**$245**
	Lower range unit in °C or °F		Thermocouple type		Upper range limit in °C or °F	
2 WTX-	☐	-	RTD	-	☐	**$245**

Dimensions

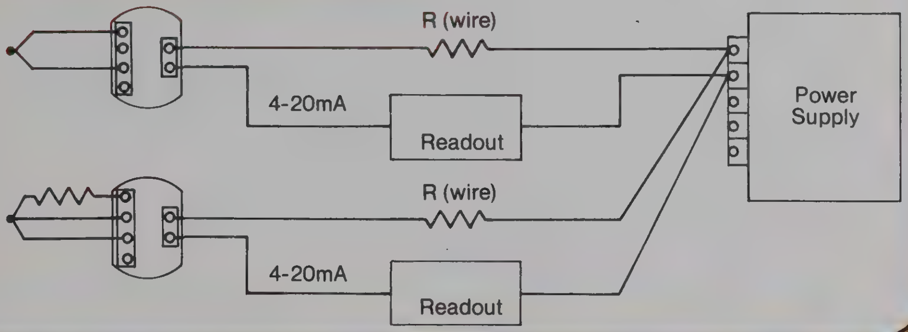


2-Wire Transmitter Power and Output Considerations

A Single supply can power more than one transmitter.

T/C in, 4-20 mA out:
R_{max}(each loop) = (V supply-12V)/20mA

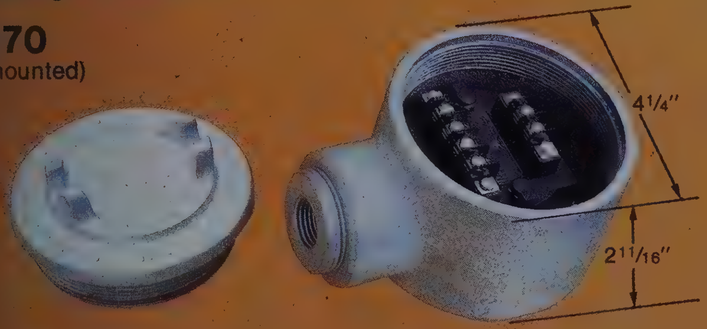
RTD in, 4-20 mA out:
R_{max} (each loop) = (V supply-16V)/20mA



Accessories

Explosion proof housing with mounting plate
Catalog No. NEP-TX

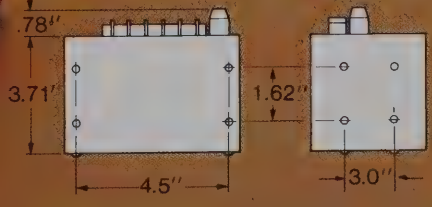
$70
(mounted)



OMEGA Series 400B Readouts with Option 4-20 mA are compatible with our 2-Wire Transmitters.

Specify either Model 400B I-3 (4-20 mA) for a 1° readout or 410B I-3 (4-20 mA) for a 0.1° readout.
Accuracy of these units are as follows:
Model 400B—1° readout ±1 count.
Model 410B—0.1° readout. Accuracy is 0.1° of reading ±1 count.

Unregulated Power Supplies for 2-Wire Transmitters



110 VAC input – 10°C to + 65° operating range.
Standard Model will accommodate up to 5 transmitter loops. Order Model No. U24Y100. Output: 24 VDC base 1000 mA. Price—**$85**
Model U48Y 40 for high resistance (long run) loops. Output 48 VDC 400 mA. Price—**$100**

Process Loop Indicator

Model TX-81

+ 81.0
OMEGA ENGINEERING, INC.
PROCESS INDICATOR TX-81
OMEGA ENGINEERING, INC
TX53
THERMOCOUPLE TRANSMITTER
INPUT
OUTPUT
S
Z

Rugged Metal Ca

Model TX81

$229

Installs anywhere in the loop!

Put a

DISPLAY

ANYWHERE IN YOUR

- ±1999 count full span display
- Powered entirely by signal loop
- 4-20 mA or l0-50 mA range
- Field scaling and offset to ±1999 counts
- Dust and oil resistant JIC/NEMA enclosure
- Versatile

Transmitter and Sensor

NB1 Sensor Section B

NEW!

**he Model TX-81 Process Loop
ndicator** is a versatile meter that can
e used in any transmitter loop. It
rovides an easy-to-read liquid crystal
isplay (LCD) from your 4 to 20 mA or
0 to 50 mA transmitter. The JIC/
EMA enclosure provides environ-
ental protection for use in most
ndustrial applications. It can be used
pressure, temperature, humidity or
ny process variable measurement
pplications where a two wire
ansmitter is required. No external
ower is needed. The TX-81 works off
our existing current loop power
upply and has a voltage drop of only
27 Volts. The independent adjust-
ents for zero and span over the
ntire 4000 count range allow one
odel to be used for most process lab
pplications. Simply scale the display
match the input range from your
ansmitter.

μMEGA Acquisition and Control Instruments
Section R

Easy-To-Use!
Off-The-Shelf Delivery!

TRANSMITTER LOOP

Power Supply
Section L $85

Operating Characteristics

Electrical

Linearity	±2 Counts
Resolution	500 PPM of full scale
Temperature Range	0°C to 50°C
Span Range	2000 Counts

(High Reading minus Low Reading)

	Min.	Typical	Max.
Offset Range Low	−200	—	+200 Counts
Offset Range Positive	−72	—	+2000 Counts
Offset Range Negative	−2000	—	+72 Counts
Update Rate	2.2	2.5	2.7 Updates/Sec.
Voltage Drop 20 mA (4 mA to 20 mA)	3.18	3.22	3.27 Volts
Equivalent Resistance @20 mA (4 mA to 20 mA)	159	161	164 Ohms
Voltage Drop 50 mA (10 mA to 50 mA)	3.16	3.20	3.24 Volts
Equilvalent Resistance @50 mA (10mA to 50 mA)	63	64	65 Ohms

Physical

JIC Enclosure

**16-gage steel construction EGP-I-1967;
NEMA Type 13 Neoprene-gasketed Cover
Mylar Lens Overlay**

Dimensions:

H: 4¼″ **W:** 7″ (with brackets 7½″)
D: 3⁵⁄₁₆″ **Weight:** 3 lbs.

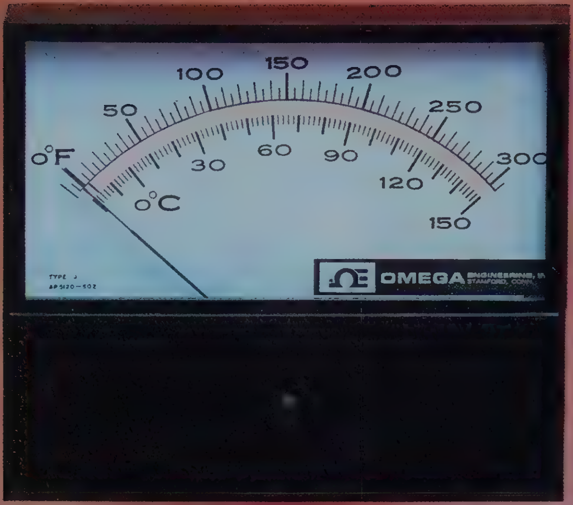
Display

0.5″ LCD, 4½ Digits
3½ Digits of data, + LSD
Switch programmed zero, °F, °C
Sign Reversal Switch
Decimal Point Switches
Overrange Indication
MSD, decimal point, and LSD displayed, all others blanked

To Order

Specify: Model TX81 Process Indicator

$229


0°F
50
100
150
200
250
300
30
60
90
120
150
0°C
OMEGA ENGINEERING, INC.

Thermocouple Electronic Readout Meter

Electronic Pyrometers with Built-in Thermocouple Amplifier

Model EP-1 $225

- ***2% Accuracy***
- ***Mirrored Scales***

Model EP-1 utilizes a solid state amplifier circuit. This eliminates most thermocouple resistance problems and allows accurate indication with one-second full scale response time. Standard indicating accuracy is ±2% of span. Electrical cold junction compensation provides more accurate compensation than bimetal for ambient temperature changes (±150µv over 40° to 120°F). The unit operates on 120 volts AC, 50/60 Hz. Mirrored scales are standard. Readings are in both Fahrenheit and Centigrade. Meter movement is a high torque, 0-1 milliampere type.

Stock ranges are indicated on the range table. Offset (suppressed) and non-stock ranges are available on special order. Maximum offset is 75%. There is also a small charge for special scales if required.

Ranges		Thermocouple Type	Model EP-1 Part No.	Max. T/C Resistance (ohms)*	Price
☐ −200 to +100°F	−125 to +35°C	T	EP1-6104		$22
☐ −25 to +125°F	−30 to +50°C	J	EP1-6344		25
☐ 0 to 150	−20 to +66	J	EP1-6304		25
☐ 25 to 225	0 to 110°C	J	EP1-5704		22
☐ 0 to 300	−15 to +150	J	EP1-6904	1000	22
☐ 0 to 500	0 to 260	J	EP1-7604		22
☐ 0 to 800	0 to 430	J	EP1-8604		22
☐ 0 to 1000	0 to 500	J	EP1-8804		22
☐ 0 to 1500	0 to 800	K	EP1-9104		22
☐ 0 to 2000	0 to 1100	K	EP1-9304		22
☐ 0 to 2500	0 to 1370	K	EP1-9504		22

*Exceeding the maximum may produce offset error of 1% or more. Accuracy is 1% at 25°C ambient. Input impedance is 1 ohms per millivolt. J signifies Iron-Constantan. K signifies Chromel-Alumel. T signifies Copper-Constantan.

0°C
20
40
60
80
100
20°F
60
100
140
180
230
OMEGA ENGINEERING, INC.

0°F
100
200
300
400
500
0°C
50
100
150
200
250
OMEGA ENGINEERING, INC.

Model EP-2 $225

Thermistor Electronic Readout Meter

(Dimensions Same as EP-1)

Designed for use with Omega Precision Interchangeable Thermistors. *See Section F for a complete selection of thermistor sensors to use with these meters.

Ranges	Thermistor*	Part no.
−10°C to +110°C and +25°F to +230°F	44004 44005 44007	EP2-32J4 EP2-33J4 EP2-35J3

Electronic Readout for the OMEGA Precision Interchangeable Thermistors

Also Available:

Bench Stand, $11. Catalog #EPL-450
Recorder output, 0-1 volt auxiliary output. $75
Three wire line cord. $6

Model EP-3 $225

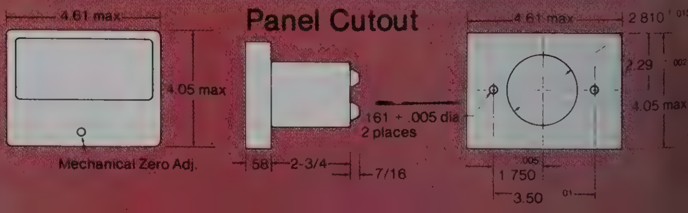
RTD Electronic Readout Meter

(Dimensions Same as EP-1)

Designed for use with the OMEGA TYPE PR Platinum Resistance Thermometers (RTD's) 100 ohm. See Section E for RTD's to use with these meters.

Ranges		Part no.
☐ −150° to +100°F	−100°C to +35°C	EP3-3104
☐ −100 to +1000	−70°C to +500	EP3-4104
☐ +30°F to +220°F	0 to +100	EP3-5704
☐ 0 to +300	−20 to +150	EP3-6904
☐ 0 to +500	0 to +260	EP3-7604
☐ 0 to +1000	0 to +500	EP3-8804

Panel Cutout


4.61 max
4.05 max
Mechanical Zero Adj.
58
2-3/4
7/16
161 + .005 dia
2 places
4.61 max
2 810
2.29
4.05 max
.005
1 750
3.50
01

Self-powered Analog Thermocouple Readout Meters

- *ALL RANGES*
- *ALL SIZES*
- *ALL CALIBRATIONS*

"OFF THE SHELF"

0°F
50
100
150
200
250
300
0°C
30
60
90
120
+150
OMEGA
0°F
200
400
600
800
100
200
300
400
0°C
OMEGA
100
200
300
400
500
0°C
50
100
150
200
250
OMEGA
0°F
100
200
50
100
150
0°C
OMEGA
OMEGA
OMEGA

Series 4000

Series 7000

Largest Single Source in the World!

Series 4000 Pyrometers

with Built-in Automatic Compensation and Heavy-Duty Construction

0 °F 50 100 150 200 250 300
-20 0 °C 30 60 90 120 +150
0 °F 100 200 300 400 500
-20 0 °C 50 100 150 200 250 +260
T/C TYPE J T/C
EXT RES 10Ω
OMEGA

All Calibrations “OFF-THE-SHELF”

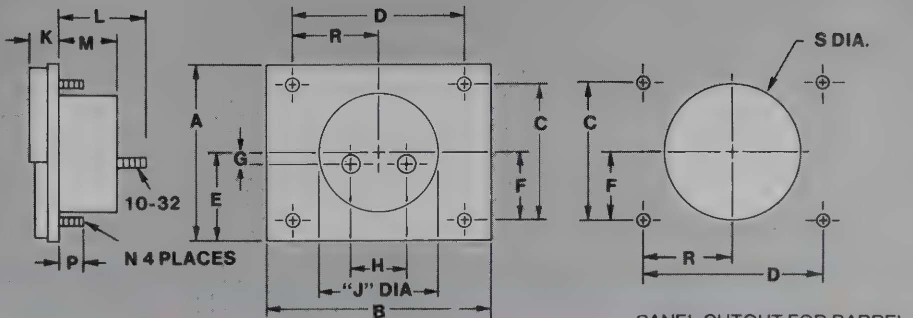
3 Sizes Availab
3½ inch
4½ inch
5½ inch

All OMEGA thermocouple direct reading meters offer these performance features:

- Standard taut band movements in all ranges assure rugged, frictionless operation and nearly perfect repeatability.
- Self shielding movements allow interchangeable mounting in steel or aluminum panels.
- Standard accuracy is ±2% of full scale at 77°F ambient temperature. Model 4055 ranges are all standard ±1% accuracy.
- Current sensitivity of all thermocouple readout meters is approximately 4 ohms per millivolt (250 microamperes). All thermocouple ranges calibrated for 10 ohms external resistance, and supplied with an adjustable 10 ohm resistor for use with thermocouples of lower resista
- Automatic bimetal cold junction compensation for c in ambient temperature on Thermocouple Readout
- Mirror scales are standard on all meters.
- Series 4000 readout meters are all-new with a three choice of mounting — front mount, bezel mount or l mount. Phenolic cases and fronts are rugged and re Glass windows are scratch-proof and free of static electricity.

ries 4000

lvanced Performance atures Omega ermocouple Automatic mpensating Direct adout Meters



PANEL CUTOUT FOR BARREL

band movements to assure low friction operation and repeatability.

elded movements allow for interchangeable mounting in steel or num panels.

ndard accuracy is ±2% of full scale (at 77°F ambient temperature). Model ranges are ±1% accuracy.

rmistor type copper error compensation on all meters.

rent sensitivity is approximately 4 ohms per millivolt (250 Microamperes) thermocouple readout meters. All ranges calibrated for 10 ohms external ance. Adjustable 10 ohm resistor for use with thermocouples of lower ance is supplied with all meters.

omatic bimetal cold junction compensation corrects for changes in nt temperature on all models.

or scales are standard.

neters come in rugged and reliable polystyrene cases. Glass windows are h proof.

p resistance of the thermocouple circuit must be matched to that of the ut meter (10 ohms). Matching is accomplished by means of the adjustable or which is attached to the back of the pyrometer.

litional adjustable resistors $5.50 each.

METER SIZE	A	B	C	D	E	F	G	H
3½"	2.87	3.70	2.25	2.25	1.44	1.12	0	1.12
4½"	3.96	5.10	3.55	3.98	1.74	1.54	0	1.12
5½"	4.49	5.72	2.98	5.25	1.59	.85	.65	1.50

METER SIZE	J DIA	K	L	M	N	P	R	S
3½"	2.63	.41	1.80	1.30	#4-40	.50	1.12	2.75
4½"	2.63	.51	1.80	1.30	#6-32	.50	1.99	2.75
5½"	2.73	.53	1.70	1.30	#6-32	.60	2.62	2.75

Temperature Ranges. °F	°C	Thermocouple*	ANSI Type	3½ Inch Case Model 4035 (2% FS accuracy) Part No.	Price	4½ Inch Case Model 4045 (2% FS accuracy) Part No.	Price	5½ Inch Case Model 4055** (1% FS accuracy) Part No.	Price
50 to +150°F	−150 to + 50°C	Cu/C	T	4035T150	$80	4045T150	$90	4055T150	$105
50 to +250		Cu/C	T	4035T250		4045T250		4055T250	
50 to +250	−100 to +120	I/C	J	4035J250	↕	4045J250	↕	4055J250	↕
00 to +600	− 70 to +310	I/C	J	4035J600		4045J600		4055J600	
75 to +225	− 60 to +110	I/C	J	4035J225		4045J225	$90	4055J225	$105
0- 300	0- 150	I/C	J	4035J300		—	—	—	—
0- 500	0- 260	I/C	J	4035J500	$80	4045J500	$90	—	—
0- 750		I/C	J	—	—	—	—	4055J750	$105
0- 800	0- 430	I/C	J	4035J800	$80	—	—	4055J800	$105
0-1000	0- 500	I/C	J	4035J1000	$80	—	—	—	—
0-1000		C/A	K	4035K1000	$80	—	—	4055K1000	$105
0-1500	0- 800	C/A	K	—	—	4045K1500	$90	4055K1500	
0-2000	0-1100	C/A	K	4035K2000	$80	4045K2000	$90	4055K2000	↕
0-2500	0-1370	C/A	K	4035K2500	$80	4045K2500	$90	4055K2500	
00 to + 600	− 70 to +310	Ch/C	E	—	—	4045E600	$90	4055E600	
00 to +1100	− 70 to +550	Ch/C	E	—	—	—	—	4055E1100	$105
00 to + 100	−130 to + 40	Ch/C	E	—	—	—	—	—	—
5 to + 225	− 60 to +110	Ch/C	E	—	—	4045E225	$90	4055E225	$105
0- 300	0- 150	Ch/C	E	—	—	—	—	4055E300	$105
0- 500	0- 260	Ch/C	E	—	—	—	—	—	—
0- 800	0- 430	Ch/C	E	—	—	—	—	—	—
0-1500	0- 800	Ch/C	E	4035E1500	$80	—	—	—	—
0-3000	0-1650	Pt/Pt 13% Rh	R	—	—	4045R3000	$90	4055R3000	$105

n, construction and specifications subject to change. OMEGA NEERING unconditionally guarantees materials and workman- Jpon inspection by OMEGA, it will repair, replace or refund the ase price of any product or material found to be defective. t for such repair, replacement, or refund, no other warranty is d.

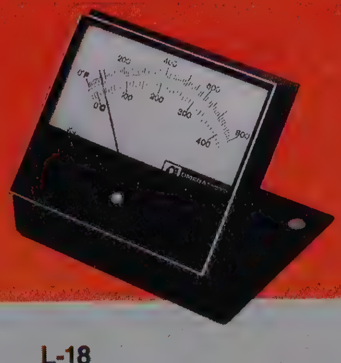
signifies Copper vs. Constantan; I/C signifies Iron vs. tantan; C/A signifies Chromel vs. Alumel; Ch/C signifies nel vs. Constantan; Pt/Pt 13% Rh signifies Platinum vs. um 13% Rhodium.

l 4055 comes in a rugged case with 1% FS accuracy, wise similar to Models 4035 and 4045.

Bench Stands — $15.00 each

Heavy gauge, anodized aluminum bench stands are available for most pyrometer models. These simplify many laboratory applications. See table for models and part numbers.

Can be used with Omega Models 4000 and 7000 readout meters.

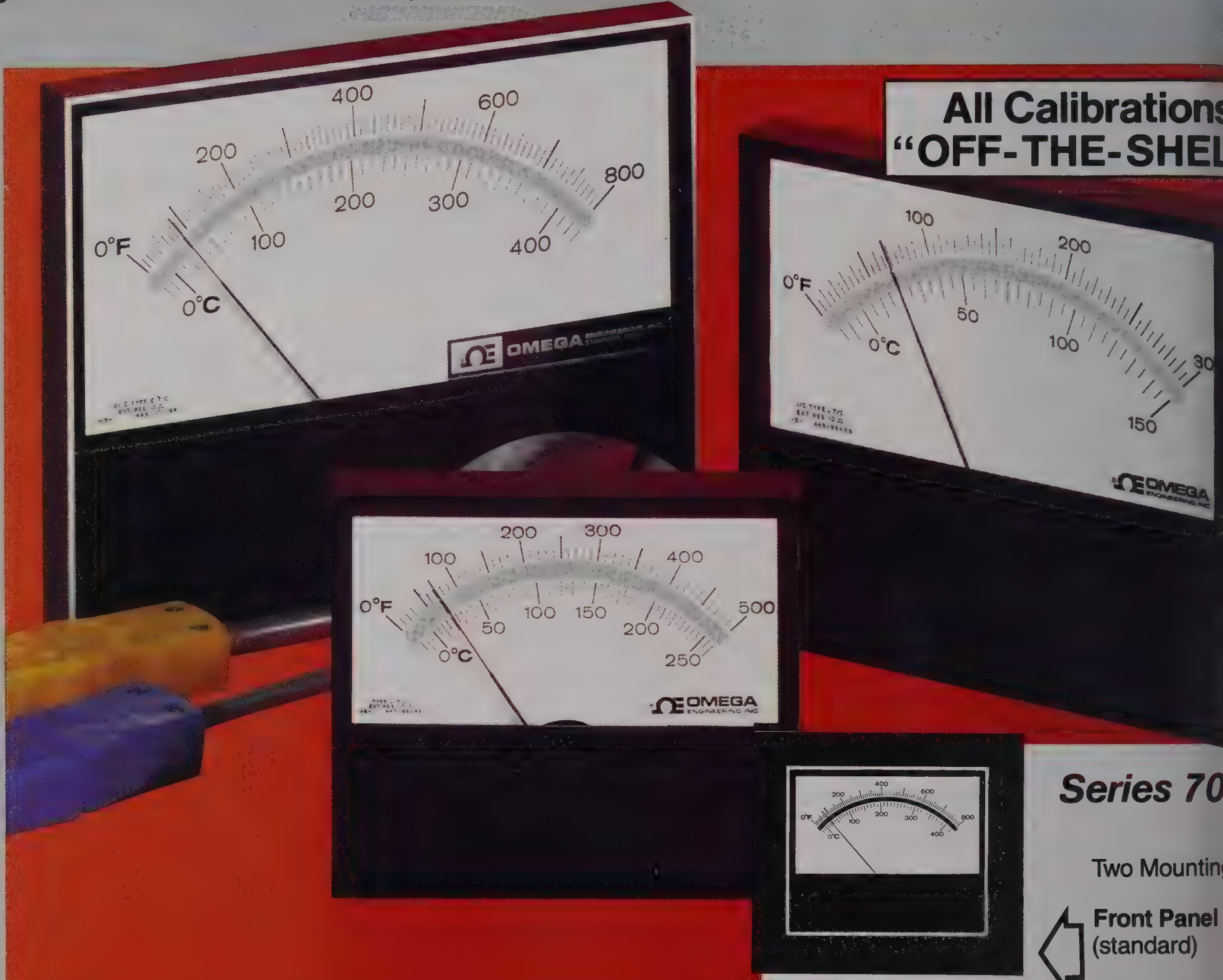


Pyrometer Model	Bench Stand Part No.
3½"	S-35
4½"	S-45
5½"	S-55

Series 7000 Readout Meters

OMEGA® High Performance Readout Meters

Basic Series 7000 design has a black front and scratch-proof glass windows. Area below scale accepts "stick-on" color plates.



All Calibrations
"OFF-THE-SHEL

All OMEGA thermocouple direct reading meters offer these performance features:

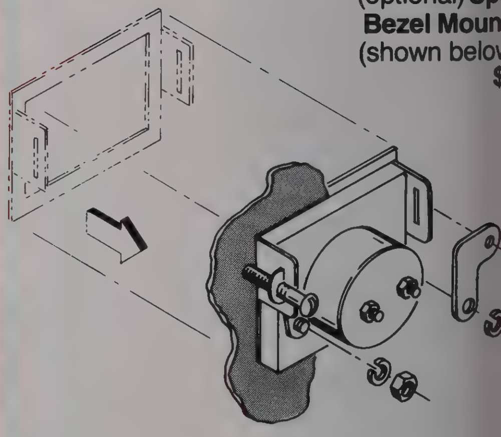
- Standard taut band movements in all ranges assure rugged, frictionless operation and nearly perfect repeatability.
- Self-shielding movements allow interchangeable mounting in steel or aluminum panels.
- Standard accuracy is ±2% of full scale at 77°F ambient temperature. Model 7055 ranges are all standard ±1% accuracy.
- Current sensitivity of all thermocouple readout meters is approximately 4 ohms per millivolt (250 microamperes). All thermocouple ranges calibrated for 10 ohms external resistance, and supplied with an adjustable 10 ohm resistor for use with thermocouples of lower resistance.
- Automatic bimetal cold junction compensation for changes in ambient temperature on Thermocouple Readout Meters.
- Mirror scales are standard on all meters.
- Series 7000 readout meters are all-new with a three-way choice of mounting — front mount, bezel mount or lens mount. Phenolic cases and fronts are rugged and reliable. Glass windows are scratch-proof and free of static electricity.

Series 70

Two Mountin

Front Panel
(standard)

Rear Panel
(optional) **Sp**
Bezel Moun
(shown belo
S



ch Stands —
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These simplify many
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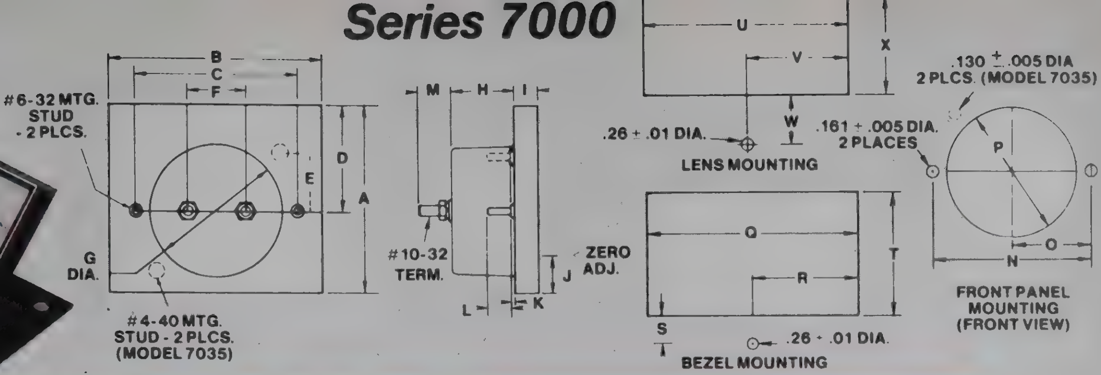
meters.

Series 7000


B
C
F
#6-32 MTG. STUD - 2 PLCS.
D
E
A
G DIA.
#4-40 MTG. STUD - 2 PLCS. (MODEL 7035)
M
H
I
#10-32 TERM.
ZERO ADJ.
J
L
K
U
V
X
W
.26 ± .01 DIA.
LENS MOUNTING
Q
R
T
S
.26 ± .01 DIA.
BEZEL MOUNTING
.130 ± .005 DIA 2 PLCS. (MODEL 7035)
.161 ± .005 DIA. 2 PLACES
P
O
N
FRONT PANEL MOUNTING (FRONT VIEW)

nsions
es
0

Model	A	B	C	D	E	F	G	H	I	J	K	L
7035	3.01 MAX.	3.51 MAX.	— —	1.53 MAX.	1.125 ±.01	1.25 ±.01	2.79 MAX.	1.37 MAX.	.58 MAX.	.53 ±.02	.02 MAX.	.56 ±.01
7045	4.05 MAX.	4.61 MAX.	3.50 ±.01	2.29 ±.02	— —	1.25 ±.01	2.79 MAX.	1.37 MAX.	.58 MAX.	.77 ±.02	.02 MAX.	.56 ±.01
7055	4.53 MAX.	5.66 MAX.	4.50 ±.01	2.695 ±.02	— —	1.25 ±.01	2.79 MAX.	1.37 MAX.	.58 MAX.	.845 ±.02	.02 MAX.	.56 ±.01

Model	M	N	O	P	Q	R	S	T	U	V	W	X
7035	.675 MAX.	— —	1.125 ±.010	2.810 ±.015	3.718 +.030 -.000	1.859 +.015 -.000	.44 ±.01	2.156 +.030 -.000	3.105 ±.015	1.552 ±.008	.76 ±.01	1.515 ±.015
7045	.675 MAX.	3.50 ±.01	1.750 ±.005	2.810 ±.015	4.812 +.030 -.000	2.406 +.015 -.000	.63 ±.01	2.75 +.03 -.00	4.205 ±.015	2.102 ±.008	.95 ±.01	2.125 ±.015
7055	.675 MAX.	4.50 ±.01	2.250 ±.005	2.810 ±.015	5.875 +.030 -.000	2.937 +.015 -.000	.64 ±.01	3.156 +.030 -.000	5.240 ±.015	2.620 ±.008	.98 ±.01	2.500 ±.015

nges in stock.

Temperature Ranges. °F	°C	Thermocouple*	ANSI ±Type	Model 7035 (2% accuracy)		Model 7045 (2% accuracy)		Model 7055 (1% accuracy)	
				Part No.	Price	Part No.	Price	Part No.	Price
0 to +100°F	130 to + 40°C	Cu/C	T	7035-T-100	$90	7045-T-100	$100	7055-T-100	$115
0 to +250	—	Cu/C	T	—	—	7045-T-250	▲	7055-T-250	$115
to +225	60 to +100	Cu/C	T	—	—	7045-T-225		—	—
0 to +250	100 to +120	I/C	J	7035-J-250	$90	7045-J-250		7055-J-250	$115
0 to +600	70 to +310	I/C	J	7035-J-600	▲	7045-J-600		7055-J-600	▲
5 to +225	60 to +110	I/C	J	7035-J-225		7045-J-225		7055-J-225	
0- 300	0- 150	I/C	J	7035-J-300		7045-J-300		7055-J-300	
0- 500	0- 260	I/C	J	7035-J-500		7045-J-500		7055-J-500	
0- 800	0- 430	I/C	J	7035-J-800		7045-J-800		7055-J-800	
0-1000	0- 500	I/C	J	7035-J-1000		7045-J-1000		7055-J-1000	
0-1000	—	C/A	K	7035-K-1000		7045-K-1000		7055-K-1000	
0-1500	0- 800	C/A	K	7035-K-1500		7045-K-1500		7055-K-1500	
0-2000	0-1100	C/A	K	7035-K-2000	▼	7045-K-2000	▼	7055-K-2000	
0-2500	0-1370	C/A	K	7035-K-2500	$90	7045-K-2500	$100	7055-K-2500	
0 to + 100	130 to + 40	Ch/C	E	—	—	—	—	7055-E-100	
0 to + 600	70 to +310	Ch/C	E	—	—	—	—	7055-E-600	
0 to +1100	70 to +550	Ch/C	E	—	—	—	—	7055-E-1100	
5 to + 225	60 to +110	Ch/C	E	7035-E-225	$90	—	—	7055-E-225	
0- 300	0- 150	Ch/C	E	7035-E-300	$90	7045-E-300	$100	7055-E-300	
0- 500	0- 260	Ch/C	E	—	—	—	—	7055-E-500	
0- 800	0- 430	Ch/C	E	7035-E-800	$90	—	—	7055-E-800	
0-1500	0- 800	Ch/C	E	—	—	—	—	7055-E-1500	
0-3000	0-1650	Pt/Pt 13% Rh	R	7035-R-3000	$90	7045-R-3000	$100	7055-R-3000	▼
0-3000	0-1650	Pt/Pt 10% Rh	S	—	—	—	—	7055-S-3000	$115

gnifies Copper vs. Constantan; I/C signifies Iron vs. Constantan; C/A signifies Chromel vs. Alumel;
3% Rh signifies Platinum vs. Platinum 13% Rhodium; S signifies Platinum vs. Platinum 10% Rhodium.

unt Schedule:

units	Net	25-100 units	10%
4 units	5%	101-500 units ...	15%

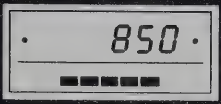
MODEL 747 DIGITAL THERMISTOR THERMOMETER
199.9
OMEGA ENGINEERING, INC. STAMFORD CT U.S.A.
PROBE A
PROBE B
A
B
A-B
OFF
°C
°F
-30°C to +50°C
-22°F to +122°F
0°C to +100°C
+32°F to +199.9°F
DEGREE
K CHROMEL ALUMEL
CALIBRATED RANGE -50° To 1250°C
1063 C
OMEGA ENGINEERING MODEL 199A
AC LINE MONITOR 47 To 1000 Hz
CALIBRATED RANGE 0 To 300 V ac
+115 V
OMEGA ENGINEERING MODEL 199G
SIGNAL MONITOR
INPUT RANGE 0 To 10 V
-88.3
OMEGA ENGINEERING MODEL 199E
RATE
SINE OR INPUT
+179.3
OMEGA ENGINEERING MODEL 199C
PANEL METER
CALIBRATED RANGE ± 199.9 mV
199.9 mV
OMEGA ENGINEERING MODEL 199F
RMS dc To 20 kHz
CALIBRATED RANGE 0 To 1.999 V
+224 V
OMEGA ENGINEERING MODEL 199H
CURRENT LOOP MONITOR
INPUT RANGE 4 To 20 mA
+704
OMEGA ENGINEERING MODEL 199D
CHANNEL
POWER
ON OFF
TEMP
°C °F
2166A DIGITAL THERMOMETER
OMEGA
157°C

1208
OMEGA
DIGICATOR™
°C
Power Pack/Potentiometer 407
INP
TPUT
BATTERY
ADJUST
ALIBRATED RANGE
170.0° To 199.9°C
°C
GA ENGINEERING, INC.
STAMFORD, CONN. 06907
Thermometer 5800
on
celsius
fahrenheit
probe
-30
50°
0
100°
-22
122°
32
198°
1
2

M Digital Instruments For Temperature, Pressure and Other Process Measurements

NEW 199 Letter Series Industrial Process Indicators M-3

Model 650/660 Microprocessor Digital Thermometer M-17

Series 400 Precision Industrial Displays M-23


Model 199 Digital Thermometer Panel and Bench Models M-31

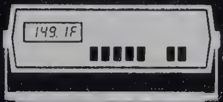
NEW Model 115 Low Cost Digital Thermometer M-38

NEW MDP-8 Multiplexer and Panel Mount Scanner M-40

NEW Series CL6500 Precision Calibrators and Bench Thermometers M-42

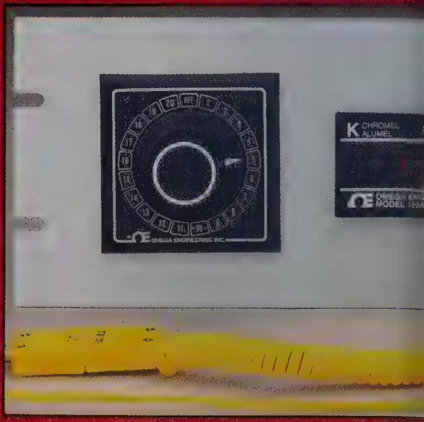
Series 2160A/2170A High Performance Digital Thermometers M-46

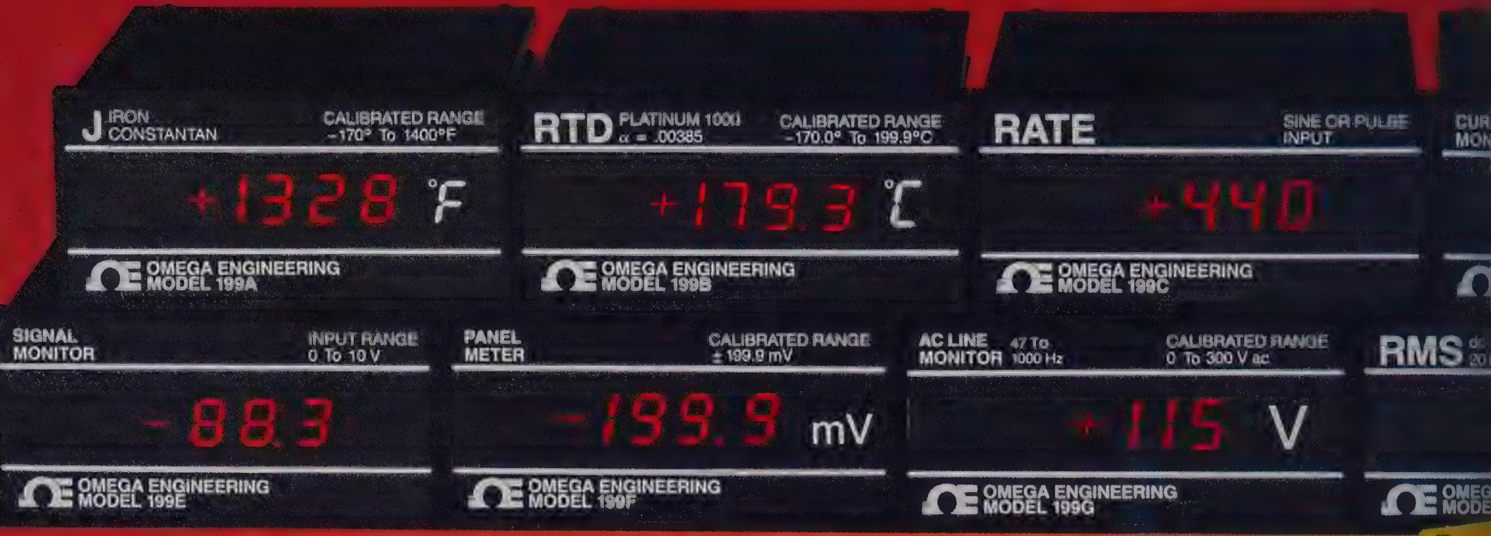
Model 747 Dual Input Thermistor Thermometer M-54

Model 5800 Thermistor Thermometer M-56


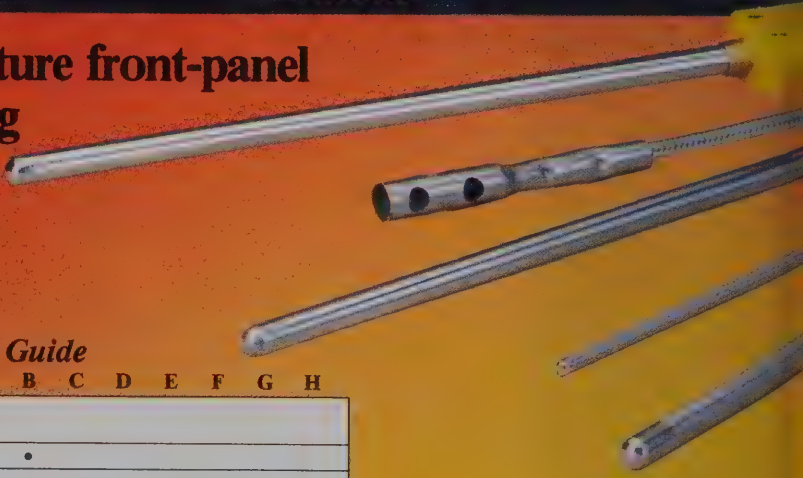
Family of Hand Held Digital Thermometers M-58

PROCESS MONITORS—
Expanded "199 Letter" Series Digital Process Indicators Fulfills all your Process Monitoring Requirements


K CHROMEL ALUMEL
OMEGA ENGINEERING MODEL 199A


J IRON CONSTANTAN
CALIBRATED RANGE −170° To 1400°F
+1328 °F
OMEGA ENGINEERING MODEL 199A
RTD PLATINUM 100Ω α = .00385
CALIBRATED RANGE −170.0° To 199.9°C
+179.3 °C
OMEGA ENGINEERING MODEL 199B
RATE
SINE OR PULSE INPUT
+440
OMEGA ENGINEERING MODEL 199C
SIGNAL MONITOR
INPUT RANGE 0 To 10 V
−8.83
OMEGA ENGINEERING MODEL 199E
PANEL METER
CALIBRATED RANGE ± 199.9 mV
−199.9 mV
OMEGA ENGINEERING MODEL 199F
AC LINE MONITOR
47 To 1000 Hz
CALIBRATED RANGE 0 To 300 V ac
+115 V
OMEGA ENGINEERING MODEL 199G
RMS

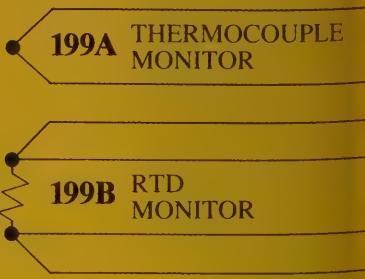
Digital process indicators feature front-panel switch-selection of engineering units and solderless installation.

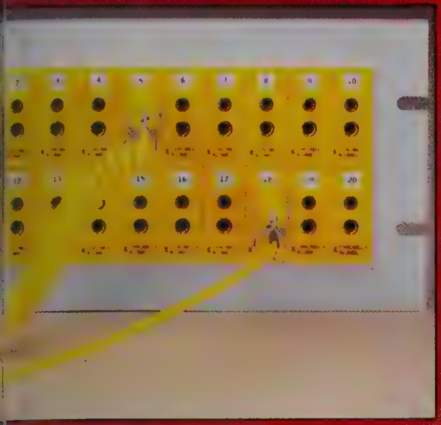


Quick Product Selection Guide

	199 A	B	C	D	E	F	G	H
Transducer Input								
Thermocouple Input*	•							
RTD (100-ohm Platinum) Input		•						
Rate Transducer Inputs**			•					
Analog Input Full Scale Range								
0 to 20mA FS Input				•				
4 to 20mA FS Input				•				
10 to 50mA FS Input				•				
0 to 50mA FS Input				•				
0 to 5Vdc FS Input					•			
1 to 5Vdc FS Input					•			
0 to 10Vdc FS Input					•			
−10 to +10Vdc FS Input					•			
0 to 200m Vdc FS Input						•		
0 to 2Vdc FS Input						•		
Selectable FS Input, dc Voltage or Current						•		
0 to 1.999Vac rms FS Input								•
0 to 19.99Vac rms FS Input								•
0 to 199.9Vac rms FS Input							•	•
0 to 300Vac rms FS Input							•	•
0 to 199.9mAac rms							•	•
0 to 1.999Aac rms							•	•
	7	8	9	10	11	12	13	14

*Thermocouple Types B, E, J, K, R, S, T, and N.
**Sinewave or Pulse Inputs.


199A THERMOCOUPLE MONITOR
199B RTD MONITOR



INPUT RANGE
4 To 20 mA
04
D RANGE
V
V

See sections A, B, D, E and F for the largest selection of temperature probes and sensors anywhere!

The 199 Letter Series is a completely new family of industrial process indicators designed for installation convenience and on-the-job flexibility. Capable of accepting the input from virtually any sensor or transducer, this series can be set up to display your process values—from the front panel. Thus, once installed, the indicator is adaptable to new measurement needs—without removal from its case! In addition, a screw-terminal version enables fast, solderless hookup of each monitor.

Unmatched Monitoring Capability

The 199 Letter Series can be applied to better than 95% of all process variables used today—temperature, pressure, flow, voltage and current. Moreover, combining our experience with other measurements, such as level, torque, horsepower, pH, among others, with a modular design, we can address your unique sensor interface requirements.

199A ◆ Thermocouple Monitor covers a range from −180 to +1820° C (−245 to +1999° F) of any one of 8 T/C types. Input is cold junction compensated and linearized to 1.0° C conformity of published NBS tables.

199B ◆ RTD Monitor measures and displays 100 Ohm platinum resistance sensor output with 1.0° C or 0.1° C resolution; includes built-in sensor excitation.

199C ◆ Rate Monitor accepts any pulse or sine input over a wide range of amplitude and frequency.

199D ◆ Current-Loop Receiver converts inputs from a variety of different current transmitters into user selectable engineering units.

199E ◆ Voltage Receiver converts inputs from a variety of different voltage transmitters into user selectable engineering units.

199F ◆ Voltage and Current Monitor measures from 0 to 200Vdc with optional DIP switch selection of full scale range.

199G ◆ ac Line Monitor measures ac input from 0 to 300 volts or 0 to 200 mA full scale and displays rms values.

199H ◆ True rms Monitor accepts inputs from dc to 20kHz and displays 0 to 300 volts rms, or 0 to 200 mA rms full scale.

Packaged for Industry

Choose from two rugged enclosures. Instruments are packaged using a standard UL94V-O rated, high-impact plastic case or an optional heavy gage metal case, each complying with DIN/NEMA standard dimensions. Both cases provide high immunity from temperature, shock, vibration, dust, water and smoke, while in addition the metal case shields against electrical pickup. Front panels are tension-sealed with a flexible optical filter, sealing out the elements, yet allowing easy access to set up switches.

Universal Powering

All models can be ordered to suit your power source. Power ranges are available from dc to 470Hz ac, including +5Vdc, +8 to +28Vdc, 110Vac or 220Vac. Built-in power flexibility broadens your choice of site selection, be it large scale plant, remote, or battery operated installations.

Isolated from Power Ground

Isolated inputs from ac power ground ensure a high degree of measurement integrity, otherwise not possible, when large potential differences between reference grounds exist. The instruments, therefore, eliminate the errors associated with ground loops.

Family Features:

◆ Front panel, DIP switch setup; easy, fast and flexible calibration

◆ Screw-terminal connector; quick, solderless installation

◆ Wide input ranges built in; handles wide swings of input signals

◆ Parallel BCD output; communicates with computer peripherals, printers

◆ Analog output; transmits data to auxiliary monitoring and recording equipment

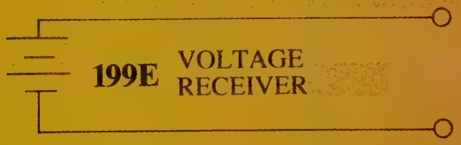
◆ High-impact plastic or ruggedized metal case; operates in severe environments

◆ Large, bright LED digits; clear, easy viewing from a distance

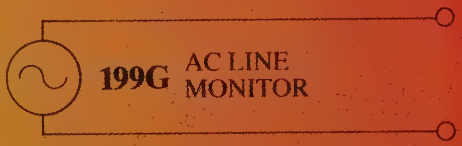
◆ Wide operating temperature range; −10 to +50° C

199C
RATE/FREQUENCY
MONITOR

199D
CURRENT LOOP
MONITOR

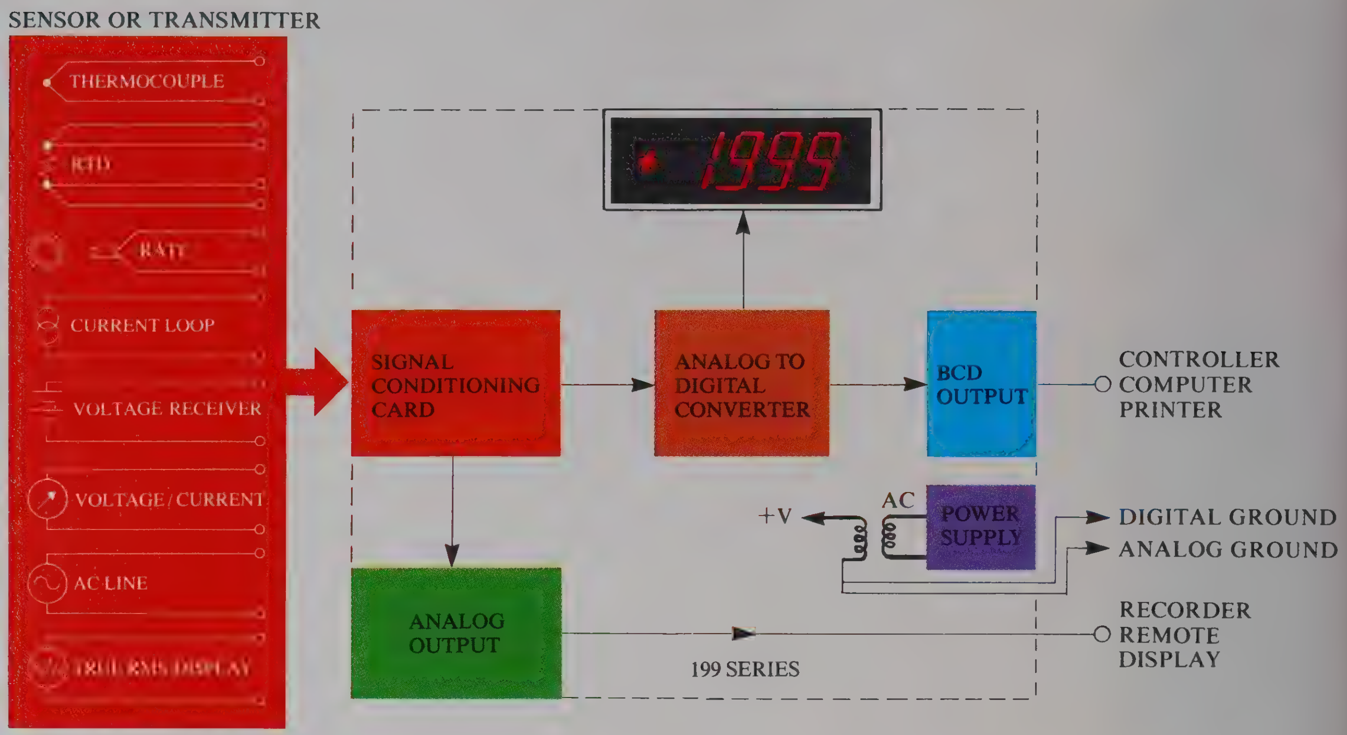


199F
VOLTAGE/CURRENT
MONITOR



199H
TRUE RMS
DISPLAY

The Design Concept


SENSOR OR TRANSMITTER
THERMOCOUPLE
RTD
RATE
CURRENT LOOP
VOLTAGE RECEIVER
VOLTAGE / CURRENT
AC LINE
TRUE RMS DISPLAY
1999
SIGNAL CONDITIONING CARD
ANALOG TO DIGITAL CONVERTER
BCD OUTPUT
CONTROLLER
COMPUTER
PRINTER
+V
AC
POWER SUPPLY
DIGITAL GROUND
ANALOG GROUND
ANALOG OUTPUT
199 SERIES
RECORDER
REMOTE
DISPLAY

199 Letter Series meets all your 3½-Digit Monitoring needs.

The 199 Letter Series is a modular design comprising several functional cards; signal input and conditioning, analog-to-digital converter (A/D), and display. This built-in modular construction facilitates Series 199 interfacing to many different transducers, sensors and transmitters — at lower cost.

Power and Signal Conditioning
Configured to accept 110 or 220 Vac ±20%, +5 Vdc, or +8 to +28 Vdc power, the internal power supply provides regulated voltage (+5 and −5Vdc) and isolation (up to 3000Vdc or ac peak) between signal and ac power ground.

The Conditioning Cards accept a wide variety of input ranges that you define via easily accessible DIP switches or plug-in modules. Simply by removing the front filter, you adjust gain and offset to match your input requirement.

A single pole optimized filter provides normal mode rejection and over-voltage protection. The filtered signal is then amplified and auto-zeroed using timing signals from the A/D Converter. Potentiometers or DIP switch selectable gain resistors scale the instrument to the required engineering units. In addition, an analog output amplifier produces the analog equivalent to the displayed value for driving auxiliary recording and monitoring equipment.

Conversion and Output
The A/D Card converts the scaled analog signal into a digital data train every 400ms. Employing an auto-zeroed, dual slope, integration type analog-to-digital conversion, drifts in offset and component values are compensated automatically for each conversion cycle. The resulting displayed data is the digitized ratio of the input signal to the pre-cision internal reference. A latched and buffered parallel BCD output option is available providing 13 lines for digits, 1 for polarity, and 1 for print command. Signals for timing, status, and control (Table 1) are also available, extending the Series 199 to systems applications.

TABLE 1. Timing, Status and Control Signals.

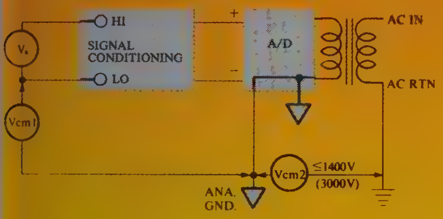
SIGNAL	CAUSE	EFFECT	APPLICATION
OVERRANGE (Output)	Conversion result exceeds ±1999 counts	Output goes low	Blanks display except for polarity and decimal point
EOC (Output)	At end of conversion cycle	Generates positive output pulse	Updates display and synchronizes other recording equipment
DISPLAY TEST (Input)	Grounding this input	Lights all segments	Checks operation of all segments of each display digit
HOLD (Input)	Maintaining this input low	Retains and displays the results of last conversion and keeps value latched in buffered output registers of BCD option	Freezes displayed value on command for data gathering
BLANK (Input)	Grounding this input	N/A	Blanks display except for polarity and decimal point

Reliability, Consistent Performance

Every OMEGA design — without exception—is subjected to a rigorous "worst-case" analysis before it is released to manufacturing. This practice ensures quality and consistency in production, with economically high yield. Our QA programs are comprehensive, rigidly applied, and subjected to continuing review and refinement.

All OMEGA products — standard and custom—are tested on computer-programmed automatic test equipment (ATE). Thus, optimum test reliability is achieved at the lowest possible cost. For example, rigid incoming inspection measures like 100 hours of IC burn-in followed by elevated temperature testing, and power-and-temperature-cycling in final test of *every unit* ensures complete quality control.

Design features ensuring high reliability include supercool packaging and maximum power dissipation for high MTBF operation, high-impact plastic and heavy gage metal enclosures, and internal over-voltage protection on the signal lines. A comprehensive quality control certificate/calibration report shipped with every instrument warrantees rated performance.

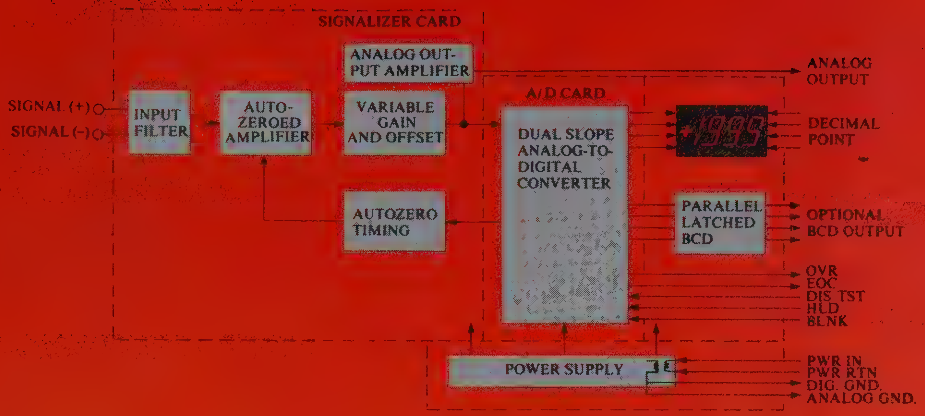

HI
Vs
SIGNAL CONDITIONING
LO
Vcm1
+
-
A/D
AC IN
AC RTN
Vcm2
≤1400V (3000V)
ANA. GND.

Vcm1 = Common Mode Voltage to Analog Ground
Vcm2 = Vcm1 Common Mode Voltage, Analog Ground to ac Power
HI/LO = Transducer Connections
ANA. GND. = Reference Ground for Transducer Input
DIG. GND. = Digital ground. Internally connected to analog ground via Kelvin connection. All digital signals, such as Decimal Points, HOLD, BLANK, EOC, DISPLAY TEST, OVERRANGE, BCD etc. should be returned to this point.

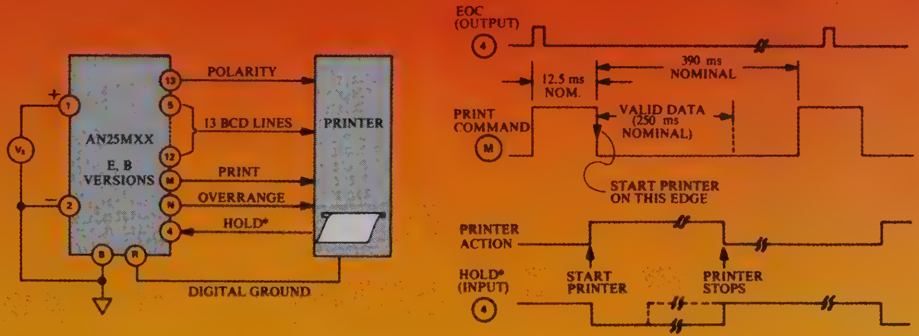
Input Configurations and Common Mode Voltage.

User Control

Each Series 199 contains a bank of switches and pots, usually accessible from the front panel, providing fingertip control of instrument setup. Simply remove the tension-fit protective filter, position the switches to match the process, replace the filter and the monitor becomes an integral system component.

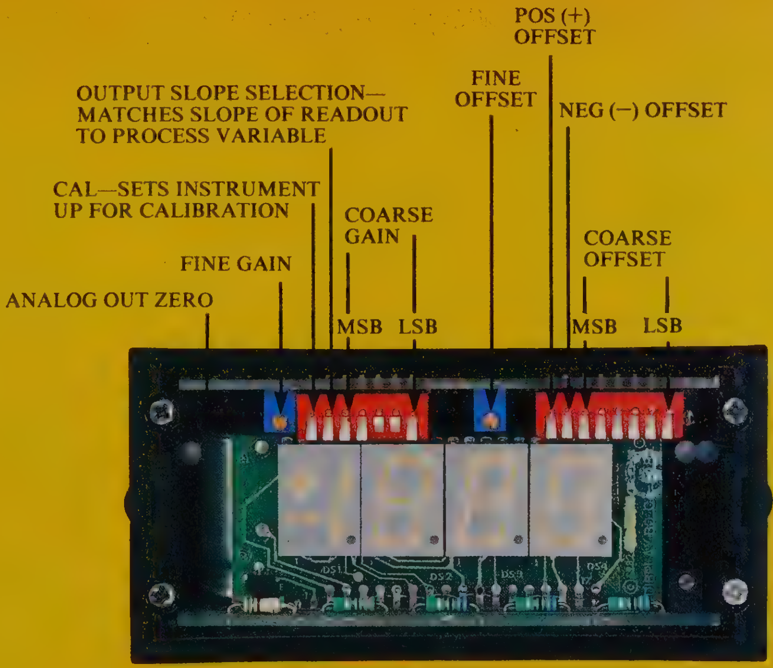

SIGNALIZER CARD
ANALOG OUTPUT AMPLIFIER
SIGNAL (+)
SIGNAL (-)
INPUT FILTER
AUTO-ZEROED AMPLIFIER
VARIABLE GAIN AND OFFSET
AUTOZERO TIMING
A/D CARD
DUAL SLOPE ANALOG-TO-DIGITAL CONVERTER
-1999
PARALLEL LATCHED BCD
ANALOG OUTPUT
DECIMAL POINT
OPTIONAL BCD OUTPUT
OVR
EOC
DIS TST
HLD
BLNK
POWER SUPPLY
PWR IN
PWR RTN
DIG. GND.
ANALOG GND.

199 Letter Series Functional Block Diagram.


+
Vs
−
1
2
AN25MXX
E, B VERSIONS
13
5
12
M
N
4
B
R
POLARITY
13 BCD LINES
PRINT
OVERRANGE
HOLD*
PRINTER
DIGITAL GROUND
EOC (OUTPUT)
4
12.5 ms NOM.
390 ms NOMINAL
PRINT COMMAND
M
VALID DATA (250 ms NOMINAL)
START PRINTER ON THIS EDGE
PRINTER ACTION
HOLD* (INPUT)
4
START PRINTER
PRINTER STOPS

*If Printer is unable to operate at a rate of 2.5 readings/second, HOLD control signal from Printer may be used to synchronize panel instrument measurements to speed of printer.

Using D-Version with Printer.


POS (+) OFFSET
FINE OFFSET
NEG (−) OFFSET
OUTPUT SLOPE SELECTION—MATCHES SLOPE OF READOUT TO PROCESS VARIABLE
CAL—SETS INSTRUMENT UP FOR CALIBRATION
COARSE GAIN
COARSE OFFSET
FINE GAIN
ANALOG OUT ZERO
MSB
LSB
MSB
LSB

Example of Front Panel Setup using Voltage Monitor.

Temperature Thermocouple Monitor 199A

Accepting inputs from any one of 8 different thermocouple types, the 199A provides linearization and cold-junction compensation for the entire usable range of each T/C, from -180 to +1820°C (-245 to +1999°F). The unit adapts to T/C types J, K, T, E, R, S, B or N by installing one plug-in component, providing reliable linearization to specified conformity (Table 3) in °C or °F.

J IRON CONSTANTAN
CALIBRATED RANGE -170° To 1400°F
+1328 °F
OMEGA ENGINEERING MODEL 199A

199A **$257**

Features:

- ◆ Automatic zero, cold-junction compensation, indication of polarity, open thermocouple and protection from shorted-T/C-to-ac
- ◆ High input impedance reduces effects of lead-length error
- ◆ High immunity to ac noise, shock, vibration, humidity and temperature extremes
- ◆ Designed to IEC-348 Class II safety standards
- ◆ All screw-terminal connections

Specifications—

(See page M-16 for additional specifications.)

Thermocouple Input

Thermocouple Types	B, E, J, K, R, S, T, and N
Input Impedance	100MΩ nom. (referenced to analog ground)
External (Lead) Resistance Effect	20μV per 350Ω of lead resistance
Cold-Junction Compensation	Automatic, ±0.03°C/°C from +10°C to +40°C, +0.05°C/°C from 0°C to +50°C ambient
Thermocouple Burnout	Same indication as OVER-RANGE. (See Table 1.)
Thermocouple Short to ac Line	No effect, automatically protected
Maximum Common Mode Voltage Between Input & Power-Line Ground	±1400Vdc (B Version), ±3000Vdc or ac peak (Standard)
Common Mode Rejection Ratio	130dB, ac power to signal low with 250Ω unbalance
Normal Mode Rejection Ratio	100dB @ 50 or 60Hz

Performance

Readout Accuracy	±½ digit @ 25°C plus conformity error. (See Table 3.)
Temperature Resolution	1°C or 1°F
Range Tempco	50ppm/°C typ. 80ppm/°C max.

Analog Output

Voltage	1mV/degree, linearized and buffered (referenced to analog ground)
Current	2mA drive capability, short circuit protected
Tempco	10μV/°C max.

How to Order

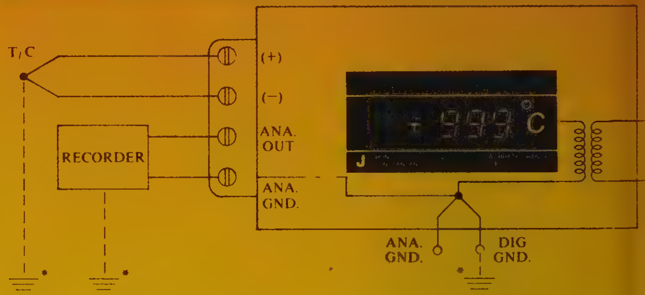
Description 199A- ☐-☐-☐
$257

Thermocouple Type
°C or °F

Options:

A - Analog Output	$30
D - Digital Output	$30
B - Card Edge Connection	N/C
Z - Dummy Zero	$18
M - Metal Case	$30

Indicate Input Power if not 110 Vac (5Vdc, 220Vac, 8-28 Vdc)



*Only one of these connections to earth.

Signal Connections.

TABLE 3. Range & Accuracy Data.

Listed below in °C and °F, are the standard ranges available for the specified thermocouple types. Note that beyond the listed range limits, the 199A will continue to measure and display accurate information with a slight increase in conformity error.

Thermocouple Type	Range		Conformity		Total Reading Accura	
B	745° to 1820°C		±0.7°C		±1.9°C	
E	-95° to 840°C	-75° to 1440°F	±0.8°C	±1°F	±2.1°C	±2.5°F
J	-180° to 760°C	-170° to 1400°F	±0.5°C	±0.5°F	±1.5°C	±1.5°F
K	-50° to 1250°C	-50° to 1999°F	±0.8°C	±1°F	±2.1°C	±2.5°F
R	300° to 1750°C	200° to 1999°F	±1°C	±1°F	±2.5°C	±2.5°F
S	335° to 1750°C	100° to 1999°F	±0.9°C	±1°F	±2.3°C	±2.5°F
T	-150° to 400°C	-245° to 750°F	±0.5°C	±1°F	±1.5°C	±2.5°F
N	-15° to 1300°C		±0.8°C		±2.1°C	

Temperature RTD Monitor 199B

Supplying excitation for a 100-ohm Platinum RTD sensor (∝ = 0.00385), the 199B accommodates 2, 3 or 4 wire wire sensing for improved accuracy. It displays temperature with 1.0° resolution from −200 to +800° C (−328 to +1472° F) and 0.1° resolution from −160.0 to +199.9° C (−199.9 to +199.9° F)

RTD
PLATINUM 100Ω
α = .00385
CALIBRATED RANGE
−170.0° To 199.9°C
+179.3 °C
OMEGA ENGINEERING
MODEL 199B

Features:

- ◆ Automatic compensation for external lead resistance for 3 or 4 wire sensing allows separation of sensor from readout without loss of accuracy
- ◆ Front panel switch selection of setup for 3 or 4 wire sensing and readout of °C or °F
- ◆ Wide range of outputs, including BCD, analog and signals for status control and system timing
- ◆ Designed to IEC-348 Class II safety standards
- ◆ All screw-terminal connections

199B **$244**

Specifications—

(See page M-16 for additional specifications.)

RTD Input	
RTD Type	100-ohm Platinum (Pt100) per DIN 43760 (α = 0.00385)
RTD Configuration	3 or 4-wire; switch-selectable
External Lead Resistance	100 ohms max.
Excitation Current	1mA nom.
RTD Burnout	Same indication as OVERRANGE (See Table 1)
RTD Short to ac Line	No effect, automatically protected by built-in circuits to 180V peak, 130V rms
Normal Mode Rejection Ratio	50dB @ 50 or 60Hz.
Common Mode	
Maximum Common-Mode Voltage Between Input & Power Line Ground	±1400 volts, dc or ac peak. (B Version) ±3000 volts, dc or ac peak. (standard)
Common-Mode Rejection Ratio	120dB, ac power to RTD
Performance	
Accuracy	±0.05% of reading ± ½ digit plus conformity error
Conformity	±1 digit
Range Tempco	100 ppm/°C
Calibrated Ranges	@ 1°/count: -200° C to + 800° C (-328° F to +1472° F) @ 0.1°/count: -160.0° C to +199.9° C (-199.9° F to +199.9° F)
Readout Units	Celsius (°C) or Fahrenheit (°F) readout, user-selectable on front panel
Analog Output (optional) Voltage	1mV/count, bipolar referenced to analog ground
Stability	10μV/°C
Current	±2mA drive capability, short circuit protected

See Section E for the finest selection of RTD Probes and Assemblies

How to Order

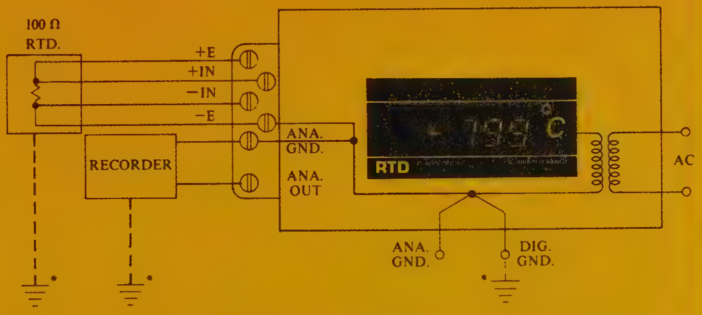
Description **199B-** ☐ - ☐ - ☐
$244

1.0° Resolution P1
0.1° Resolution P2 Add $31
°C Readout
°F Readout

Options:

A - Analog Output	$30
D - Digital Output	$30
B - Card Edge Connection	N/C
Z - Dummy Zero	$18
M - Metal Case	$30

Indicate Input Power if not 110 Vac
(5Vdc, 220Vac, 8-28 Vdc)

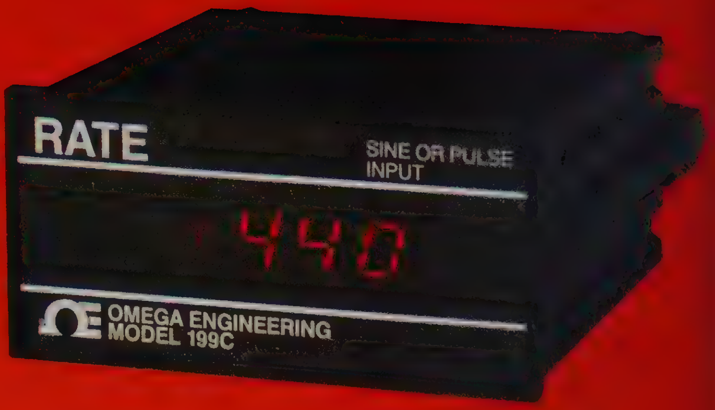


** Only one of these connections to earth.*

Signal Connections.

Rate Monitor 199C

Accepting inputs from magnetic pickups, tachometers, photocells, or any transducer generating a pulse or sine rate signal, the 199C can display preselected engineering units of rate, flow, speed, frequency or percentage. Front panel accessible switches provide on-site setup of the input signal span, data averaging, and pulse output.



199C **$247**

Features:

- Front panel switches allow flexibility to reconfigure instrumentation to meet changing measurement and readout needs
- Isolated input (to analog ground) ensure reliable data in extreme industrial conditions
- Accepts a wide variety of inputs—from millivolts to hundreds of volts, squarewaves, sinewaves and pulses
- Automatic threshold and hysteresis adjustment optimizes noise rejection
- Designed to IEC-348 Class II safety standards
- All screw-terminal connections

How to Order

Description	199C-F1- ☐ $247
Options:	
A - Analog Output	$30
D - Digital Output	$30
B - Card Edge Connection	N/C
Z - Dummy Zero	$18
M - Metal Case	$30
Indicate Input Power if not 110 Vac (5Vdc, 220Vac, 8-28 Vdc)	

Specifications—

(See page M-16 for additional specifications)

Signal Input

User selectable for sinewave or pulse input (See below)

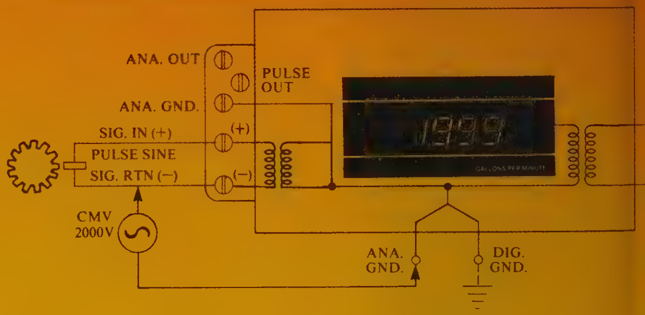
Configuration	Two wire, floating and isolated, dc coupled
Input Resistance	33kΩ in parallel with 100pF
Bias Current	50nA typ.
Input Frequency	to 10kHz
Input Protection	±300Vdc or ac rms continuous without damage
Sine Wave Input	
Input Voltage	6mVpp to 300Vpp. Sensitivity decreases @ 40dB/decade >1kHz
Hysteresis	Automatic, 10% of input signal up to 100mV max.
Pulse Input	
Polarity	Pulses to be positive with respect to signal return
Input Voltage	1.5V to 100V
Threshold Level	1V nom.
Pulse Width	50μs min.

Common Mode

Signal Input to Analog Ground	
Common Mode Voltage (CMV)	±2000Vdc or ac peak
Common Mode Rejection Ratio (CMRR)	100dB @ 50 or 60Hz
ac Power Line to Analog Ground	
Common Mode Voltage (CMV)	±1400Vdc of ac peak (B Version); ±3000Vdc or ac peak (standard)
Common Mode Rejection Ratio (CMRR)	120dB @ 50 or 60Hz

Performance

Accuracy	±0.05% of rdg. ±1 count
Resolution	0.05% for 2000 counts
Range Tempco	100 ppm/°C typ.
Step Response	User selectable in 16 steps from 0.35 s to 20 s



Signal Connections.

Rate to Analog Conversion

Technique	User programmable digital charge pump. Programmab from 10μs to 20 ms in 5μs increments
Reference	Ultra stable ceramic resona derived time base

Outputs

Pulse Output	User selectable for true or inverted output, 0 to +5Vd swing, DTL, TTL and CM compatible; 3TTL loads

Analog Output (optional)

Voltage	0 to +5Vdc output (2.5mV display count)
Current	2mA drive capability, short circuit protected
Offset Tempco	20μV/°C typ.

Current Loop Receiver 199D

Interfacing with current loop transmitters, the 199D converts inputs ranging from 0 to 20mA, 4 to 20mA, 0 to 50mA, or 10 to 50mA into the engineering units required by your application.

CURRENT LOOP
MONITOR
INPUT RANGE
4 To 20 mA
704
OMEGA ENGINEERING
MODEL 199D

199D **$232**

Features:

- Wide range front-panel switch selection of span and offset
- Easy selection from 4 input ranges
- Capable of high current shunt measurements using external 4-terminal resistors
- Floating input with respect to ac power ground eliminates ground loops
- Overcurrent indication blanks display except polarity.
- Designed to IEC-348 Class II safety standards
- All screw-terminal connections

Specifications—

(See page M-16 for additional specifications)

Signal Input	Input Current Range	0 to 20mA, 4 to 20mA, 0 to 50mA, 10 to 50mA
	Input Impedance	50Ω @ 20mA; 20Ω @ 50mA
	Input Current (max.)	70mA for 20mA FS ranges; 110mA for 50mA FS ranges
	Input Voltage Drop	1V Compliance @ 20 or 50mA
	Overcurrent Indication	20% above FS, Display blanks except for polarity
	Normal Mode Rejection Ratio	65dB typ. @ 50 or 60Hz
Common Mode	Input Signal to ac Line	±1400Vdc or ac peak (B Version); ±3000Vdc or ac peak
	Common Mode Rejection Ratio	120dB
Performance	Resolution	0.05% @ 1999 counts
	Accuracy	±0.05% rdg. ±1 count
	Range Tempco	70ppm/°C typ., 125ppm/°C max.
	Calibration Span Adjust Range	60 to 3800 counts (4 to 20, 10 to 50mA) 60 to 4000 counts (0 to 20, 0 to 50mA)
	Offset Adjust	±1999 counts
	Slope Change	Reverse input terminal connections
Analog Output (optional)	Voltage	1mV/count, bipolar referenced to analog ground
	Stability	10μV/°C
	Current	±2mA drive capability, short circuit protected

How to Order

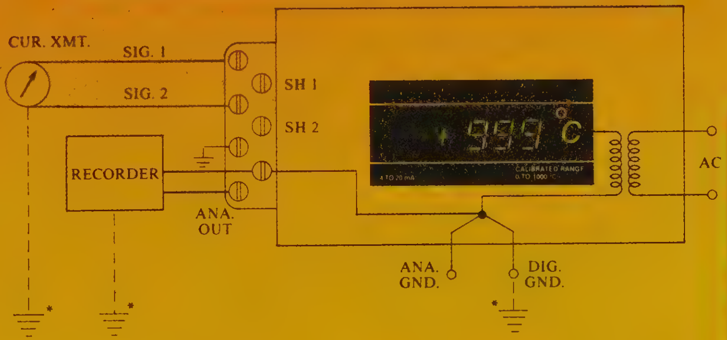
Description **199D-☐-☐**
$232

0 to 20mA Input Range - I1
4 to 20mA Input Range - I2
0 to 50mA Input Range - I3
10 to 50mA Input Range - I4

Options:

A - Analog Output	$30
D - Digital Output	$30
B - Card Edge Connection	N/C
Z - Dummy Zero	$18
M - Metal Case	$30

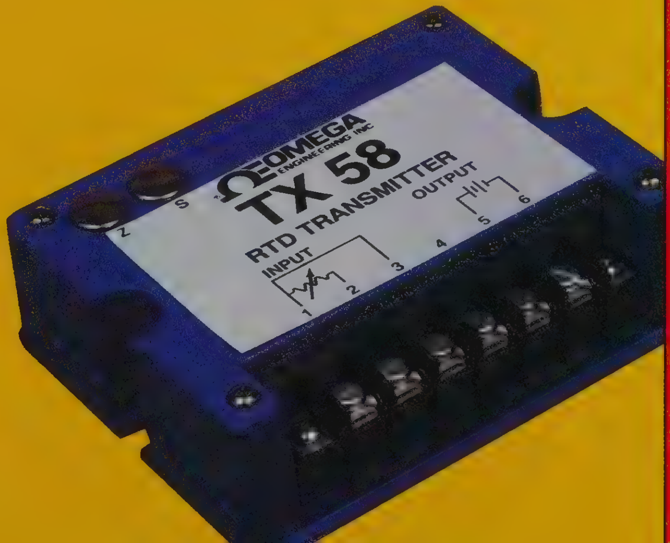
Indicate Input Power if not 110 Vac
(5Vdc, 220Vac, 8-28 Vdc)


CUR. XMT.
SIG. 1
SIG. 2
SH 1
SH 2
RECORDER
ANA. OUT
999 °C
4 TO 20 mA
CALIBRATED RANGE 0 TO 1000 °C
AC
ANA. GND.
DIG. GND.
*
*
*

* Only one of these connections to earth.

Signal Connections.

See Section L for the complete line of OMEGA Transmitters.


OMEGA ENGINEERING INC
TX 58
RTD TRANSMITTER
INPUT
OUTPUT
1
2
3
4
5
6

Voltage Receiver 199E

Interfacing with voltage transmitters, the 199E converts inputs ranging from 0 to 5V, 1 to 5V, 0 to 10V, and −10 to +10Vdc into the engineering units of your choice—temperature, pressure, flow, displacement, etc.

SIGNAL
MONITOR
INPUT RANGE
0 To 10 V
-88.3
OMEGA ENGINEERING
MODEL 199E

199E **$232**

Features:

- ◆ Wide range front-panel switch selection of span, offset and slope
- ◆ Floating input with respect to ac power ground eliminates ground loops
- ◆ Overvoltage indication and protection
- ◆ Easy to change input ranges
- ◆ Designed to IEC-348 Class II safety standards
- ◆ All screw-terminal connections

Specifications—

(See page M-16 for additional specifications.)

Signal Input	
Input Voltage Range	0 to +5Vdc, +1 to +5Vdc 0 to +10Vdc, -10 to +10Vdc
Input Impedance (max.)	100MΩ for 5V FS 100KΩ for 10V FS
Input Protection	100Vdc or ac peak
Overvoltage Indication	20% above FS, Display blanks except for polarity
Normal Mode Rejection Ratio	65dB typ. @ 50 or 60Hz
Common Mode	
Input Signal to ac Line	±1400Vdc or ac peak (B Version); ±3000Vdc or ac peak
Common Mode Rejection Ratio	120dB
Performance	
Resolution	0.05% @1999 counts
Accuracy	±0.05% rdg. ±1 count
Range Tempco	70ppm/°C typ., 125ppm/°C max.
Calibration Span Adjust Range	60 to 3800 counts (1 to 5V) 60 to 4000 counts for other ranges
Offset Adjust	±1999 counts
Slope Change	Via front panel switch and reversing input terminal connections
Analog Output (optional)	
Voltage	1mV/count, bipolar referenced to analog ground
Stability	$10\mu V/°C$
Current	±2mA drive capability, short circuit protected

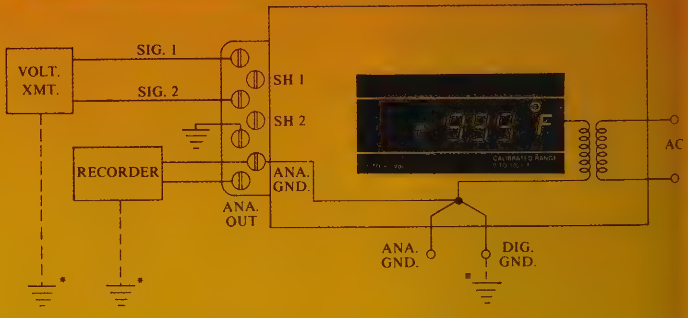
How to Order

Description	199E- ☐ - ☐ $232
0 to 5V Input Range -	E1
1 to 5V Input Range -	E2
0 to 10V Input Range -	E3
− 10 to + 10V Input Range -	E4

Options:

A - Analog Output	$30
D - Digital Output	$30
B - Card Edge Connection	N/C
Z - Dummy Zero	$18
M - Metal Case	$30

Indicate Input Power if not 110 Vac
(5Vdc, 220Vac, 8-28 Vdc)



**Only one of these connections to earth.*

Signal Connections.

See Section L for the complete line of OMEGA Signal Conditioners.

OMEGA
ENGINEERING, INC.
STAMFORD, CONN.

MODEL TAC-386

dc Voltage or Current Monitor 199F

As a voltage monitor, the standard 199F accepts from 0 to 200Vdc where you can specify a fixed full scale range (0 to ±2Vdc or 0 to ±200mVdc) or choose a switch selectable SR option with internal voltage scaling (0 to ±2V, 20V and 200Vdc). This same option includes a current monitoring capability measuring inputs from 200μA to 200mA full scale.

PANEL
METER
CALIBRATED RANGE
± 199.9 mV
-199.9
mV
OMEGA ENGINEERING
MODEL 199F

199F **$104**

Features:

- Input protected up to 300 volts dc
- Automatic zero, overrange, and polarity
- Supercool design, high MTBF
- Designed to IEC-348 Class II safety standards
- All screw-terminal connections

Specifications-

(See page M-16 for additional specifications.)

Analog Input	
Configuration	Bipolar, differential input
Full Scale Range & Input Resistance	±1.999Vdc or ±199.9mVdc; >1000MΩ Selectable range option ±1.999Vdc; >1000MΩ ±19.99Vdc; >300KΩ ±199.9Vdc; >300KΩ ±199.9μAdc; 10KΩ ±19.99mAdc; 100Ω ±199.9mAdc; 10Ω
Bias Current	50pA typ., 100pA max.
Input Protection	±300 Volts dc or ac rms continuous without damage
Input Filter	Single pole, optimized signal enhancement filter
Normal Mode Rejection Ratio	60dB typ., @ 50 or 60Hz.
Ratiometric Operation	Ratio input for use with external reference —(Consult Factory)
Common Mode	
Signal Return to Analog Ground	
Voltage (CMV)	±0.25Vdc or ac peak
dc Rejection Ratio (CMRR)	110dB typ., 90dB min.
ac Rejection Ratio (CMRR)	90dB typ., 70dB min. @ 50 to 60Hz
ac Power Line to Analog Ground	
Voltage (CMV)	±1400 Volts dc or ac peak (B Version); ±3000Vdc or ac peak (standard)
ac Rejection Ratio (CMRR)	140dB typ., 120dB min. @ 50 to 60Hz
Performance	
Accuracy	±0.05% of reading ±1 count
Resolution	±0.05% for ±1999 counts
Range Tempco	±35ppm of rdg./°C typ., ±50ppm of rdg./°C max. for 2V and 200mV FS range; ±60ppm of rdg./°C typ., ±71ppm of rdg./°C max. for all other ranges
Zero Stability	Auto zero, ±1μV/°C max. zero drift
Code Centers	Less than 20μV rms uncertainty, resulting in very stable readings
Step Response	Less than 400ms for ±0.05% of rdg. accuracy for a "+" or "–" full scale step input

How to Order

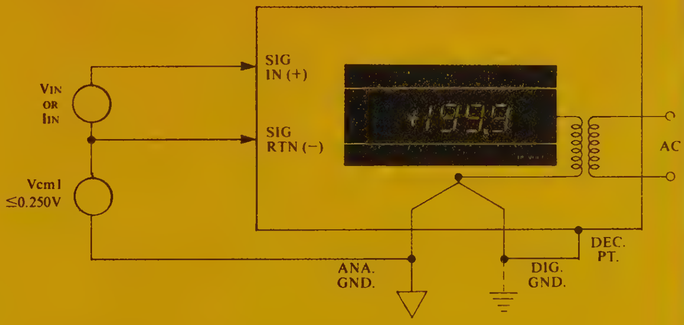
Description **199F- ☐ - ☐**
$104

V1 (2Vdc) - N/C
V2 (200m Vdc) - $8
V3 Selectable Range - $6
(B option also required)

Options:

D	- BCD Output	$30
B	- Card Edge Connection	N/C
Z	- Dummy Zero	$18
M	- Metal Case	$30

Indicate Input Power if not 110 Vac
(5Vdc, 220Vac, 8-28 Vdc)



Signal Connections.

ac Voltage or Current Monitor 199G

The 199G is an ac average-responding rms-indicating monitor measuring voltage or currents from 47 to 1000Hz with full scale readout of 0 to 300 volts rms or 0 to 200 mA rms. The unit is typically an integral component in power supply instrumentation, power substation and generating equipment or in power line monitoring.

Features:

- ◆ Accepts a wide range of inputs
- ◆ Capable of monitoring 2A full-scale with external 4-wire shunt.
- ◆ Protected to 500 volts ac without damage (voltage monitor)
- ◆ Rejects up to 3000 V dc (1400 V B Version) or ac peak between signal input and ac line
- ◆ All screw-terminal connections

Specifications—

(See page M-16 for additional specifications.)

Input	**ac Voltage**	
	Range	0 to 199.9Vac rms @ 0.1V/count 0 to 300Vac rms @ 1V/count
	Maximum Voltage	500Vac rms
	Input Impedance	330 kΩ nom.
	ac Current	
	Range	0 to 199.9mA ac rms @ 0.1mA/count 0 to 1.999A ac rms with external 4-wire, 1Ω shunt (Consult Factory)
	Voltage Drop	2Vac rms
	Frequency Range	47 to 1000Hz
Common Mode		
	Maximum Common Mode Voltage	±1400 volts dc or ac peak (Input to Power Line) (B Version); ±3000Vdc or ac peak
	Common Mode Rejection Ratio	80dB at 50 or 60Hz (Input to Power Line)
Performance		
	Accuracy	±0.05% of rdg. ±1 digit @ 25°C
	Range Tempco	100ppm/°C
	Calibration	Average value of rectified sinewave displayed as rms.
	Settling Time	0.5s for full-scale step input
Analog Output (optional)	Voltage	1mV/count, referenced to analog ground
	Stability	10µV/°C
	Current	±2mA drive capability, short circuit protected

See Section R for details on the complete line of OMEGA Computer Peripherals.

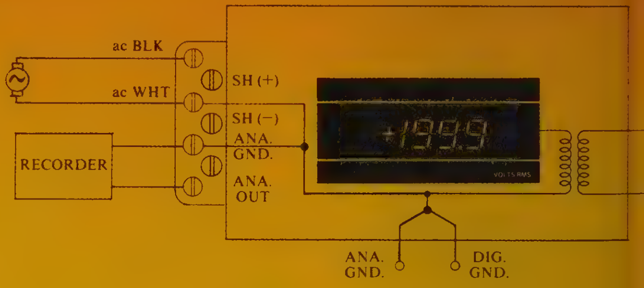
AC LINE MONITOR
47 To 1000 Hz
CALIBRATED RANGE 0 To 300 V ac
224 V
OMEGA ENGINEERING MODEL 199G

199G **$221**

How to Order

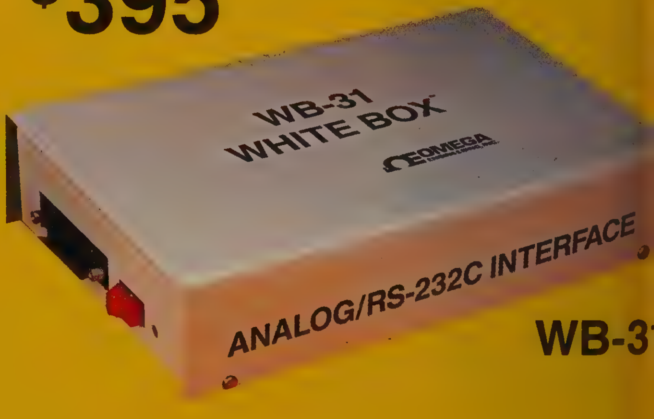
Description	199G-☐-☐ $221
0 to 199.9V Input Range -	A1
0 to 300V Input Range -	A2
0 to 199.9 mA -	A3
Options:	
A - Analog Output	$30
D - Digital Output	$30
B - Card Edge Connection	N/C
Z - Dummy Zero	$18
M - Metal Case	$30

Indicate Input Power if not 110 Vac (5Vdc, 220Vac, 8-28 Vdc)


ac BLK
ac WHT
SH (+)
SH (−)
ANA. GND.
ANA. OUT
RECORDER
+199.9
VOLTS RMS
ANA. GND.
DIG. GND.

Signal Connections.

$395


WB-31 WHITE BOX
OMEGA
ANALOG/RS-232C INTERFACE

WB-3

True rms Monitor 199H

Measuring and displaying the true rms value of a voltage or current input, the 199H can be scaled for four voltage ranges: 1.999, 19.99, 199.9 or 300V rms and one current range (199.9mA rms). Typical applications include measurement of true rms power, complex waveforms, magnetizing currents and modulated signals, as well as for audio equipment testing, among others.

RMS dc To 20 kHz
CALIBRATED RANGE 0 To 1.999 V
115 V
OMEGA ENGINEERING MODEL 199H

199H **$232**

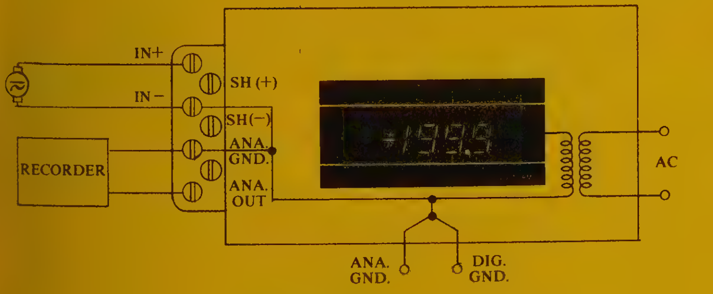
Features:

- ◆ High performance computing rms converter enables measurement of complex waveforms with digital accuracy
- ◆ Accepts inputs from dc to 20 kHz providing versatile setup with many voltage sources
- ◆ All screw-terminal connections
- ◆ Capable of monitoring 2A full-scale with external 4-wire shunt.

Specifications—

(See page M-16 for additional specifications.)

Input		
	ac Voltage	
	Range	0 to 1.999, 0 to 19.99, 0 to 199.9 or 0 to 300V rms
	Maximum Voltage	220V rms, except 500V rms on 199.9 and 300V rms ranges
	Input Impedance	1MΩ nom. (Voltage Monitor)
	ac Current	
	Range	0 to 199.9mA rms @ 0.1mA/count 0 to 1.999A rms with external 4-wire, 1Ω shunt (Consult Factory)
	Voltage Drop	2V rms
	Frequency Range	dc to 20kHz for rated accuracy
Common Mode		
	Maximum Common Mode Voltage	±1400 volts dc or ac peak (Input to Power Line) (B Version); ±3000Vdc or ac peak (standard)
	Common Mode Rejection Ratio	>80dB at 50 or 60Hz (Input to Power Line)
Performance		
	Readout Accuracy at 25°C (77°F)	±0.15% of rdg. ±1 digit from dc to 20kHz
	Crest Factor	4 at rated accuracy; 7 at 1% additional rdg. error
	Settling Time	1.2s for full-scale step input
	Zero Tempco	±0.1 least significant digit/°C
	Range Tempco	100ppm/°C
Analog Output (optional)		
	Voltage	1mV/count, referenced to analog ground
	Stability	10μV/°C
	Current	±2mA drive capability, short circuit protected



Signal Connections.

How to Order

Description	199H- ☐ - ☐
	$232
0 to 1.999V Input Range -	R1
0 to 19.99 Input Range -	R2
0 to 199.9V Input Range -	R3
0 to 300V Input Range -	R4
0 to 199.9mA Input Range -	R5
Options:	
A - Analog Output	$30
D - Digital Output	$30
B - Card Edge Connection	N/C
Z - Dummy Zero	$18
M - Metal Case	$30
Indicate Input Power if not 110 Vac (5Vdc, 220Vac, 8-28 Vdc)	

NEW MODEL!

AVAILABLE LATE 1983

Strain Gage and Pressure Monitor Model 199J

SPECIFICATIONS

Full Scale Range	5 mV to 30 mV DIP switch selectable Settable at 0.5%
Sensitivity	2.5 μV max/count DIP Switch Selectable
Offset	80% of F.S. up to 24 mV DIP switch selectable
Input Protection	±100 V dc or ac rms continuous without damage
Input Filter	5 Hz
Input Bias Current	3 nA max, 1 nA typ.
Common Mode Voltage (CMV)	±1500 V dc or ac peak (ac line to analog ground)
Excitation	5 V ±5%, floating to drive one 350Ω load cell, short circuit proof
Isolation	500 V dc or ac peak (signal return to analog ground) 1500 V dc or ac peak (ac line to analog ground)

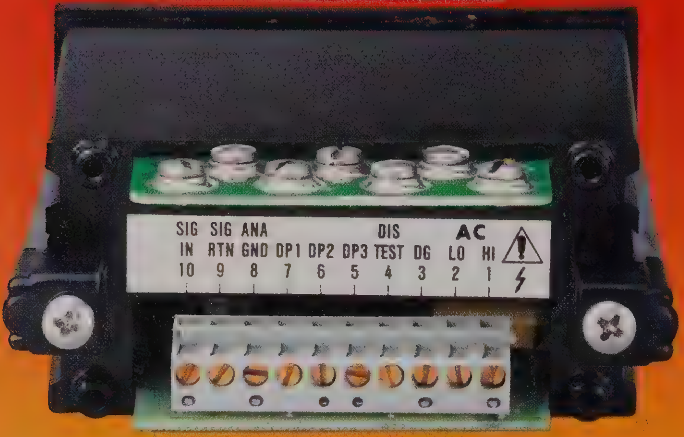
Consult Sales Department for More Information.

Options and Accessories

Standard Configuration

Screw-terminals supply 10 connection points for quick solderless hookup with up to #14 AWG wire per contact. This version is designed to meet IEC-348 Class II safety requirements. BCD output is not supplied in this version.

10	SIG IN	Signal In (+)
9	SIG RTN	Signal Return (−)
8	ANA	Analog Ground
7	DP1	Decimal Point 1
6	DP2	Decimal Point 2
5	DP3	Decimal Point 3
4	DIS TEST	Display Test
3	DIG. GND	Digital Ground
2	AC LO	AC Power Return
1	AC HI	AC Power In



Standard Pinouts and Rear Panel View.

The BCD, Option "D", a full capability model, with BCD output factory-installed and ready to be used.

Ratio Input	A	1	Signal IN (+)
Analog Ground	B	2	Signal Return (−)
Decimal Point 1	C	3	Decimal Point 2
Decimal Point 3	D	4	EOC/HOLD
BCD (2)*	E	5	BCD (1)*
BCD (8)*	F	6	BCD (4)*
BCD (20)*	H	7	BCD (10)*
BCD (80)*	J	8	BCD (40)*
BCD (200)*	K	9	BCD (100)*
BCD (800)*	L	10	BCD (400)*
PRINT*	M	11	DISPLAY TEST
BLANK/OVERRANGE	N	12	BCD (1000)*
−5.1Vdc Output	P	13	POLARITY*
Digital Ground†	R	14	+5V†
ac Power IN†	S	15	ac Power or +8 to +28Vdc IN†

*These signals are active with D-Version only.

BCD and "B" Option Pinouts and Rear Panel View.

Output Options

"A"	Analog linearized output 1 mv per degree (C or F) for one degree models, 1 mv per 0.1 degree (C or F) for 0.1 degree model. *Not field installable.*
"B"	**An expandable version** provides 30 gold plated contacts accepting a solder type, card edge connector with wire sizes up to #22 AWG. This model accommodates applications requiring control signals (EOC, OVR, Display Hold, Blank, and Test) and where system expansion will utilize BCD interfacing. BCD output can be installed using the OMEGA 199A-409 card.
"D"	Digital BCD output Parallel, latched and buffered. *Not field installable.*
409 Card	Field Installable BCD output card. Fits only 199 Letter Series instruments with "B" output option.

Power Options

110VAC	Unless otherwise specified, Digital will be supplied for 110VAC, 50-60Hz service.
220VAC	Specify "220VAC"
5DC	Specify "5VDC"
8-28VDC	Specify "8-28VDC"

Additional Options

Power Cord	3 wire power cord with 3 prong, 110VAC plug, 6 ft. long.	$ 6
PL10-5535	Connector (screw terminals)	$ 25
PL10-5563	Connector (solder terminals)	$ 10
"M"	Metal Case. Fully enclosed and shielded DIN/NEMA panel mount metal case. Specify "metal case".	$ 30
Bench Stand/ Tray	Specify "BST"	$ 17

Extra Range Modules—199A

9□□	Plug in thermocouple range module. Field installable. (Includes new faceplate)

Range Module Selection Guide

Thermocouple Type	Part No. °F	Part No. °C	Price*
K	9KF	9KC	$28 *Faceplate included
J	9JF	9JC	
T	9TF	9TC	
E	9EF	9EC	
R		9RC	
S		9SC	
B		9BC	
N		9NC	

Face Plates:

Customized face plates with engineering units available to indicate your process/variable.

CONSULT OMEGA SALES DEPARTMENT FOR BENCH CASE OPTIONS

	CONNECT J1 TERMINALS R	S	14	15
110Vac		•		•
230Vac		•		•
+5VDC	−		+	
+8 to +28 Vdc	−			+

† Table 2. Power Connections.

General Series Specifications

Display

Type	Seven segment planar LED.
Polarity Indication	Automatic, plus "+" or minus "–" sign displayed
OVERRANGE Indication	All digits blanked to prevent erroneous readout, "+" or "–" sign and decimal point remain on
Decimal Points	3 positions, externally programmable with jumper, TTL/DTL, open collector or relay logic
HOLD	Logic "0" (open collector or equivalent) holds last reading in display (B Version only)
BLANK	Logic "0" (open collector or equivalent) blanks display (B Version only)
DISPLAY TEST	Logic "0" (sink 0.2mA to digital ground) tests all 23 segments of display by displaying "1888"

Analog to Digital Conversion

Technique	Dual slope, 3 phase conversion with automatic zero correction, complete conversion each cycle
Rate	2.5 conv./s nom. internally triggered See "HOLD" command for display control
Input Integration Period	100ms nom., for optimum 50 and 60Hz noise rejection

Digital Outputs
(D Version only)

Parallel BCD (Optional)	15 parallel lines provide latched and buffered BCD output, POLARITY, and PRINT command. All are TTL/DTL and CMOS compatible, 2TTL loads each
OVERRANGE	Logic "0" indicates that input exceeds +1999 counts, CMOS compatible, 0 to +5Vdc
EOC	Falling edge of "End of Conversion" signal indicates conversion complete, CMOS compatible, 0 to +5Vdc

Power

Choice of 4 power inputs	+5Vdc ±5% @ 170mA nom. +8 to +28Vdc @ 90mA nom. (Specifically designed for Automotive, Marine, Railroad, and Aircraft applications; protected against supply reversals.) 110Vac rms ±20%, 47 to 500Hz @ 1.6 Watts nom. (88 to 132Vac input range) 220Vac rms ±20%, 47 to 500Hz @ 1.6 Watts nom. (176 to 264Vac input range) An isolated dc-to-dc converter provides up to 500 volts isolation between sensor and system ground. Consult sales department.

Environmental & Physical

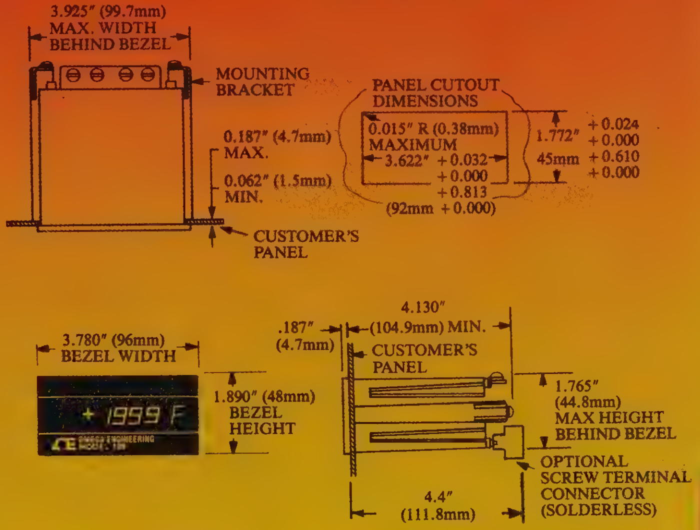
Operating Temperature Range	–10°C to +50°C
Storage Temperature Range	–40°C to +85°C
Relative Humidity	0 to 90%, noncondensing
Case	DIN/NEMA standard, high-impact molded plastic case UL94V-0 rated. Metal case available. (See Ordering Code)
Dimensions	DIN/NEMA
Weight	5 oz (150 grams) nom., dc powered; 8 oz (230 grams) nom., ac powered
EMI/RFI	Shielding on 5 sides with metal case option
Special Line Noise Supppression	Provision made for surge suppressors, varistors and line input passive Pi filtering for industrial applications. Consult factory

Reliability

MTBF	>80,000 hours, calculated
Burn-In	≥48 hours with 0°C to +50°C temperature cycles and power on/off cycles
Vibration	Vibrated at 5gs for 30s
Calibration with NBS traceable equipment	Detailed certificate of calibration shipped with each unit
Recalibration	Recommended 15-month intervals
Warranty	24 months
Safety Standard Version	Designed to meet IEC-348 Safety Class II Specifications for breakdown ac voltage and creepage distances. (Apply to 199G and 199H)

Panel Mounting

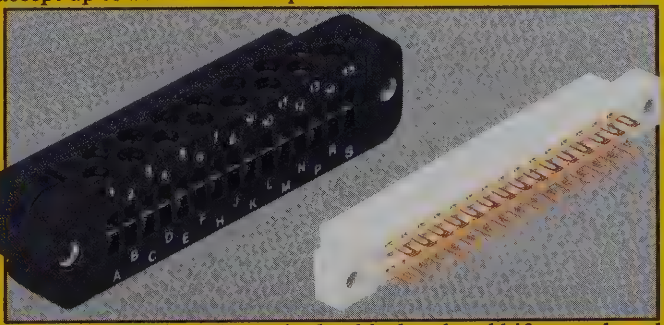
As with all Analog digital panel instruments, the 199 Letter Series accommodates panel mounts of varying sizes for both plastic and metal cases. The standard hardware shipped with each unit allows mounting into 1/16 in. (1.5mm) to 3/16 in. (4.7mm) thick panels. Larger panels however, can easily accept the instrument using longer retaining screws.


3.925" (99.7mm) MAX. WIDTH BEHIND BEZEL
MOUNTING BRACKET
0.187" (4.7mm) MAX.
0.062" (1.5mm) MIN.
CUSTOMER'S PANEL
PANEL CUTOUT DIMENSIONS
0.015" R (0.38mm) MAXIMUM
3.622" +0.032 +0.000
+0.813 (92mm +0.000)
1.772" +0.024 +0.000
45mm +0.610 +0.000
3.780" (96mm) BEZEL WIDTH
+ 1999 F
1.890" (48mm) BEZEL HEIGHT
.187" (4.7mm)
4.130" (104.9mm) MIN.
CUSTOMER'S PANEL
1.765" (44.8mm) MAX HEIGHT BEHIND BEZEL
OPTIONAL SCREW TERMINAL CONNECTOR (SOLDERLESS)
4.4" (111.8mm)

Panel Mounting Dimensions.

Accessories

The PL10-5535 is a 30 terminal gold-plated and bifurcated card edge connector. It is configured in two rows of 15 terminals, labeled 1 through 15 and A through S. The screw terminals will accept up to #14 AWG wire per contact.


A
B
C
D
E
F
H
J
K
L
M
N
P
R
S

The PL10-5563 is a 30 terminal gold-plated and bifurcated card edge connector. It is configured as two rows of 15 terminals, labeled 1 through 15 and A through S. Terminals will accept up to three soldered wires up to #22 AWG.

Digital Thermometers

Precision Microprocessor Based Models 650 and 660

THERMOCOUPLE THERMOMETER
1000 °C
OMEGA
MODEL 660
TYPE K THERMOCOUPLE THERMOMETER
125 °F
OMEGA
MODEL 650
K CHROMEL + ALUMEL −
J IRON CONSTANTAN − +

Model 660
User Programmable

Change Calibration as needed for **J, K, T, E, R,** or **S** Thermocouples

$290

Model 650

$230

High Performance at an Affordable Price

NEW!

Bench Top Models

TYPE T THERMOCOUPLE THERMOMETER
230 °C
MODEL 650
OMEGA
OFF
TYPE J THERMOCOUPLE THERMOMETER
1221 °F
OMEGA ENGINEERING, INC.
MODEL 650
POWER

Model DSS-650

Switch among 10 Thermocouples of same type

$355

- **Microprocessor accuracy**
- **Switchable °C or °F display**
- **Digital output for remote controls, displays**
- **Linear analog output for chart recorders**
- **ac or dc power**

Model DS-650

$290

Basic Bench Model—1 Input

Digital Thermometers
Precision Models 650/660

Model 650

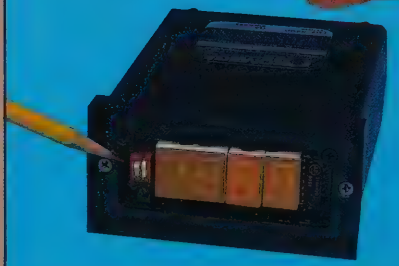
$230

OMEGA
TYPE K THERMOCOUPLE THERMOMETER
100 °C
MODEL 650
OMEGA ENGINEERING, INC.
650/660 Digital Thermometer
T/C INPUT
ANALOG OUTPUT
POWER
OMEGA ENGINEERING

Easy Connections

TYPE K THERMOCOUPLE THERMOMETER
F
OMEGA
MODEL 650
THERMOCOUPLE THERMOMETER
C
OMEGA
MODEL 660

Reversible Front Lens



Switch Selects °C/°F Scaling

Precision with flexibility

Description

The Model 650 and Model 660 are high-performance microprocessor controlled thermocouple instruments that measure temperature more accurately than other economically priced instruments. These meters are single-channel thermocouple meters capable of interfacing with four base metal thermocouple types J, K, T, E and two noble thermocouple types R and S. Thermocouple selection is factory-programmed for the Model 650 or user programmable if a Model 660 is selected. Both models have as standard a linearized digital output provided in ASCII character serial format for easy interface to printers, terminals, and other peripherals. An optional linearized one millivolt per degree (step function) analog output can be added for easy interfacing with recorders and other analog instruments.

Theory of Operation

The input signal conditioning begins with over-voltage protection which protects the instrument against input signals as high as 300 V peak. Open thermocouple detection provides a positive overrange signal to indicate that an open circuit exists at the meter input.

Self-calibration is performed through a multiplexer by switching the system between ground reference, a stable voltage reference, the cold junction sensor, and the input terminals. The microprocessor is initialized at power up and stores in memory ground and reference voltages and the cold junction temperature. In normal operation the thermocouple input terminals are measured continuously with each of the other three positions sampled periodically to update the self-calibration constants stored in memory.

Cold Junction Compensation is achieved by an electronic sensor mounted in good thermal contact with the input terminals. The microprocessor scans the sensor and uses this information to mathematically reference the thermocouple input signal to 0°C before linearization is performed.

The thermocouple linearization is accomplished in the microprocessor. The span is broken up into typically 24 linear segments which have been computer-selected to provide the least square error of segment conformity. This information is stored digitally and used for each thermocouple measurement. Since linearization is provided digitally, all conformity error due to time and temperature drift are eliminated.

Model 660 User Programmable

Changing Thermocouples is a Snap!

E THERMOMETER
°C
MODEL 660
MOMETER
°F
MODEL 650

Universal Instrument for All Applications

The Model 660 has the power of six nstruments for little more than the ost of one. The microprocessor in he unit provides six linearization rograms to be able to handle types J, K, T, E, R and S thermocouples.

Model 660 user programmable— A dip switch makes changing thermocouples a snap.

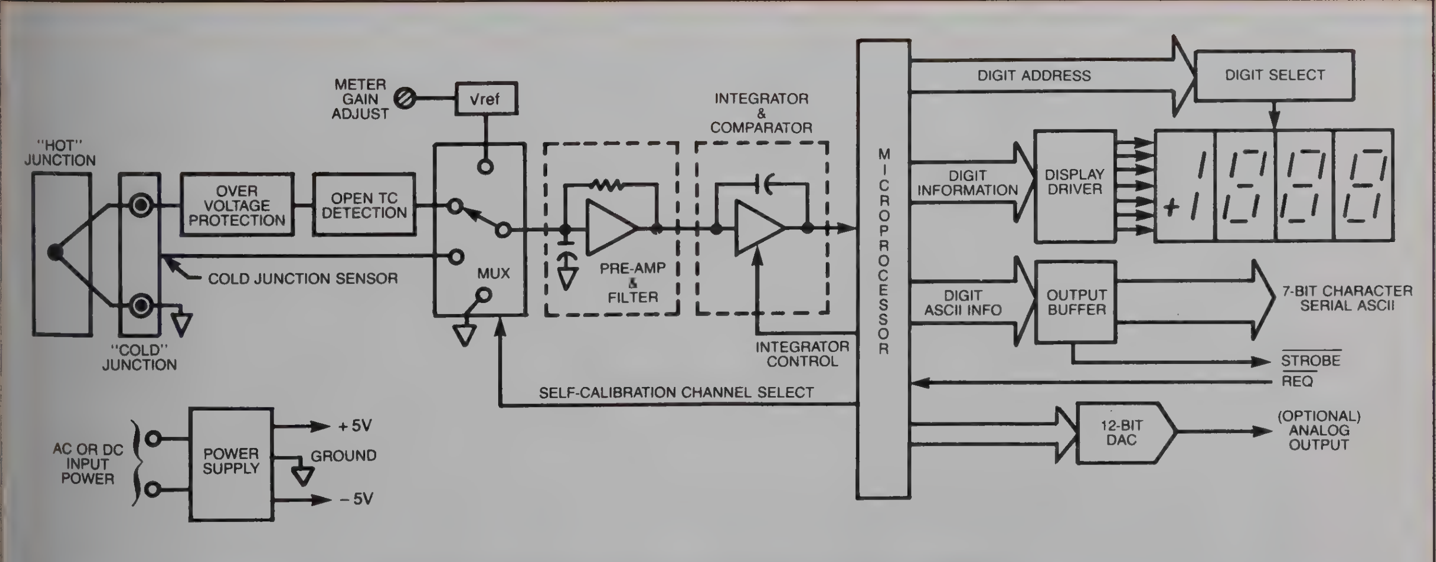
There is no need to change range modules or integrated circuit chips or to recalibrate when changing thermocouple types on the Model 660. A dip switch, easily accessible behind the display board makes changing thermocouples simple. A second dip switch under the lens and to the left of display permits changing between °C and °F. If specified, the Model 660 will be configured to meet your immediate thermocouple needs. If not specified, units will be shipped set for °C and type J calibration.

Six calibrations in one instrument

THERMOCOUPLE THERMOMETER
172°F
OMEGA ENGINEERING, INC
MODEL 660

Model 660
$290

For Information on Panels and Selector Switches, refer to Section G.


METER GAIN ADJUST
Vref
"HOT" JUNCTION
OVER VOLTAGE PROTECTION
OPEN TC DETECTION
COLD JUNCTION SENSOR
"COLD" JUNCTION
MUX
PRE-AMP & FILTER
INTEGRATOR & COMPARATOR
INTEGRATOR CONTROL
SELF-CALIBRATION CHANNEL SELECT
MICROPROCESSOR
DIGIT ADDRESS
DIGIT SELECT
DIGIT INFORMATION
DISPLAY DRIVER
+1888
DIGIT ASCII INFO
OUTPUT BUFFER
7-BIT CHARACTER SERIAL ASCII
STROBE
REQ
12-BIT DAC
(OPTIONAL) ANALOG OUTPUT
AC OR DC INPUT POWER
POWER SUPPLY
+5V
GROUND
−5V

Model 650 & 660 Functional Block Diagram

Digital Thermometers
Precision Models 650/660

THERMOCOUPLE THERMOMETER
100 °C
OMEGA
ENGINEERING, INC.
MODEL 660

Specifications

THERMOCOUPLE INPUTS

- **Thermocouple Types:** J, K, T, E, R and S
- **Input Impedance:** Over 100 MΩ
- **External (Lead) Resistance Effect:** Less than 20μV per 350Ω of Lead Resistance
- **Cold Junction Compensation Error:** ±0.5°C Max (10°C to +40°C)
- **Open Thermocouple:** + EEE Display; + EEEE ASCII Digital Output; +2.048 Analog Output
- **Thermocouple Short to ac Line:** Internal Protection Provided to 300 V Peak, (200 V ac rms)
- **Common Mode Voltage:** 1400 V peak (dc or ac) between Input and Power Line Ground (ac Versions)
- **Common Mode Rejection Ratio:** Over 130 dB with 250 Ω Source Imbalance (ac Versions); (dc to 60 Hz)
- **Normal Mode Rejection Ratio:** Over 80 dB @ 50/60 Hz

DIGITAL OUTPUTS

- **Data:** Character Serial ASCII
  Drive Capability: 2 TTL Loads, CMOS/TTL Compatible
- **Strobe:** Negative transition determines when character serial data is valid. CMOS/TTL compatible
- **Overrange:** ±EEEE
- **Character Rate:** Selectable on J1 (pin 32)
  Grounded: 25 Characters/sec. (slow)
  Open: 100 Characters/sec. (fast)
- **Minimum Time Between New Data Update:** 150 ms

DIGITAL INPUTS

- **$\overline{\text{REQ}}$:** Low-Level Triggered; must go low at any time other than during data transmission to be recognized. $\overline{\text{REQ}}$ line taken low during data transmission will not be acknowledged and the ASCII digital output transmission will not occur. Display readings are not affected by $\overline{\text{REQ}}$.

ANALOG OUTPUT (Option A)

- **Voltage:** 1 mV/degree, Fahrenheit or Celsius, Linearized. Step Function, Minimum Resolution 1 mV.
- **Current:** ±2 mA Max Drive
- **CMV:** 1400 V Peak (ac or dc) Peak Between Analog Output Ground and ac Power Line Ground
- **Overrange:** +2.048 V, −0.512 V

ACCURACY

- **Readout Accuracy:** ± ½ Digit @ 25°C plus Conformity Error (See ACCURACY in table)
- **Temperature Resolution:** 1°C/1°F
- **Range Temperature Coefficient:** ± 25ppm/°C typ; ±60ppm/°C max.
- **All ranges:** guaranteed monotonic.

ANALOG TO DIGITAL CONVERSION

- **Technique:** Offset Dual Slope with Gain and Offset Error Correction
- **Rate:** 2.5 Conversions/Second, Typical
- **Input Integration Period:** 100 ms for 50/60 Hz Noise Rejection

POWER REQUIREMENTS (Choice of Three Supply Ranges)

- **ac:** 90 V ac to 132 V ac @ 25 mA (47 to 500 Hz)
- **ac:** 198 V ac to 264 V ac @ 12.5 mA (47 to 500 Hz)
- **dc:** +7.5 V to +15 V dc @ 200 mA (Protected Against Supply Reversals)

DISPLAY

- **Type:** Seven Segment LED 0.56″ (14.3 mm) High
- **Polarity Indication:** "+" or "−" Displayed
- **Overrange Indication:** "+EEE" or "−EEE"
- **Display Test:** At Power Turn-On, 3-Second Display of "+1888" Tests All Segments of Display

ENVIRONMENTAL

- **Rated Temperature Range:** +10°C to +40°C
- **Operating Temperature Range:** −10°C to +50°C
- **Storage Temperature Range:** −40°C to +85°C
- **Relative Humidity:** 0% to 90%, Non-condensing

DIMENSIONS

- **Case:** H: 1.89″ (49 mm) x W: 3.78″ (97 mm) x D: 5.13″ (131 mm) High-impact Molded Plastic Case
- **DIN/NEMA Standard Panel Cutout:**

$$3.622'' \ \frac{+.032}{-.000}\ 92\text{ mm}\ \frac{+.8}{-0}\ \text{x}\ 1.771''\ \frac{+.024}{-.000}\ 45\text{ mm}\ \frac{+.6}{-0}$$

- **Panel Thickness:** 1/16″ (1.5 mm) to 3/16″ (4.8 mm)
- **Weight:** 15.2 oz. (431 grams) max., ac-powered
  12.0 oz. (341 grams) max., dc-powered

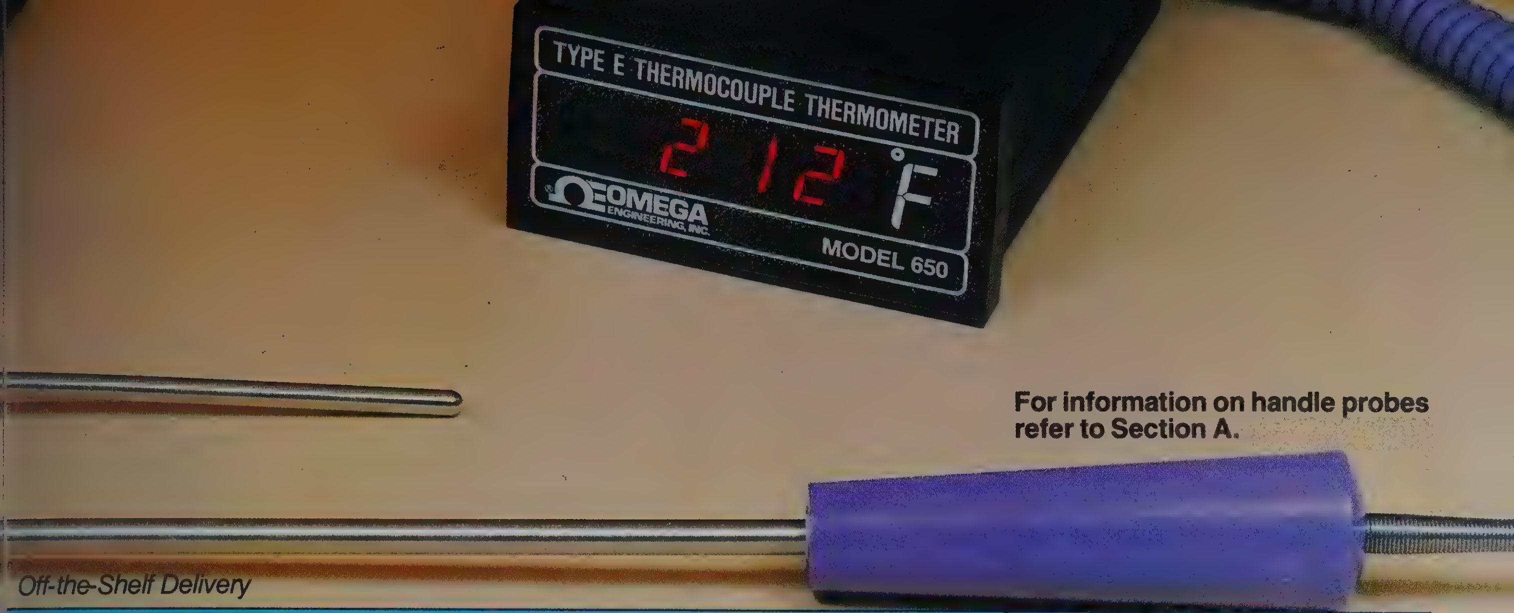
RELIABILITY

- **Burn-In:** 168 Hours with Temperature at +50°C and Power On/Off Cycles
- **Calibration:** NBS Traceable
- **Warranty:** 12 Months

CONNECTOR—(Option D)

- One 44-pin 0.1″ (2.54 mm) Spacing Card Edge Connector
- Viking 3VH22/1 JN5 or Equivalent

Specifications subject to change without notice.



For information on handle probes refer to Section A.

Off-the-Shelf Delivery

Models 650/660 Ranges and Specifications					To Order Specify:	
Sensor Type	**Material Type**	**Range**	**Accuracy***	**Resolution**	**Model 650 $230**	**Model 660 $290**
J	Iron/Constantan (Iron vs. Copper-Nickel)	−165°C to 760°C −265°F to 1400°F	± 0.7°C ± 1.3°F	1°C 1°F	**650-J**	**660 User Programmable Sensor Type**
K	Chromel/Alumel (Nickel-Chromium vs. Nickel-Aluminum)	− 50°C to 1250°C − 58°F to 1999°F	± 0.9°C ± 1.6°F	1°C 1°F	**650-K**	
T	Copper/Constantan (Copper vs. Copper-Nickel)	−150°C to 400°C −238°F to 752 °F	± 0.8°C ± 1.4°F	1°C 1°F	**650-T**	
E	Chromel/Constantan (Nickel-Chromium vs. Copper-Nickel)	−100°C to 870°C −148°F to 1598° F	± 1.0°C ± 2.0°F	1°C 1°F	**650-E**	
R	Pt 13% Rh/Pt	0°C to 299°C 300°C to 1760°C	± 6.0°C ± 1.5°C	1°C 1°C	**650-R**	
S	Pt 10% Rh/Pt	32°F to 571°F 572°F to 1999°F	± 12.0°F ± 3.0°F	1°F 1°F	**650-S**	

*Readout Accuracy: ± ½ LSD includes all conformity errors, cold junction compensation errors, gain errors and offset errors.

Ordering Information

Panel Models	Description	Price
650-[ ]-[ ]	Digital Thermocouple Thermometer with factory programmed calibration, ASCII digital output (connector optional), switch selectable °C/°F scaling, and 110 V ac 47-500 Hz power. Specify Thermocouple type J, K, T, E, R, or S. Specify output and power options, see right.	$230
660-[ ]-[ ]	Digital Thermocouple Thermometer with user programmable Thermocouple selection, ASCII digital output (connector optional), switch selectable °C/°F scaling, reversible lens, case and 110Vac 47-500 Hz power. Specify Thermocouple type J, K, T, E, R, or S. Specify output and power options, see right.	290
Bench Models		
DS-650-[ ]-[ ]	Model 650 in bench top case - single Thermocouple input. Specify Thermocouple type J, K, T, E, R or S. Specify output options, see right.	290
DSS-650-[ ]-[ ]	Model 650 in bench top case—ten Thermocouple inputs and selector switch. Specify Thermocouple type J, K, T, E, R, or S. Specify output options, see right.	355

OUTPUT OPTIONS

"A"	Analog output linearized to 1 mV per degree (°C or °F). Step function output changes in 1mV increments.	$50
"D"	Connector for ASCII digital output, 44 pins, 0.100" spacing.	10

POWER OPTIONS

100 V ac	Unless otherwise specified, units will be supplied for 110 V ac, 47-500 Hz power.	STD
220 V ac	Specify "220 V ac" power option.	10
7.5 to 15 V dc	Specify "7.5 to 15 V dc" power option.	25
Power Cord	8-ft. long, 3-wire power cord with 3-prong, 110 V ac plug and stripped end terminations.	6

ORDERING EXAMPLES:

A. Model 650-E-A

Model 650 for type E Thermocouple	$230
Analog output option	50
110 V ac power	N/C
	$280

B. Model 660-J-D-7.5 to 15 V dc

Model 660, initially set for type J Thermocouple	$290
Connector for ASCII digital output	10
7.5 to 15 V dc power	25
	$325

Digicator™ Series 400B Digita

Prices Start At $380

1800
OMEGA
78
OMEGA
436
OMEGA
22.1
OMEGA
Power Pack/Potentiometer 407
+V
-V
OUTPUT ADJUST
BATTERY
Power Pack 40
+V
-V
INPUT
BATTERY
OFF

eadout Meters

Rugged! Reliable! Accurate!

Now With 0.8 Inch Display

- Field Installable Options
- Thermocouple, RTD and Thermistor Readouts
- Plug-in Range Change Modules
- °C/°F Selection Switch
- Resolutions of 1°, 0.1° and 0.01°

544
OMEGA
E
R
K

SEE SECTION K FOR SERIES 400 CALIBRATOR!

NEW!

Standardization Means Versatility

All printed circuit boards and assemblies can be interchanged from unit to unit. Thus options plug-in and can be field installed without special instructions or wiring changes. Standardization also results in fewer failures during production, and in the field, and most important a lower cost instrument when a change is made.

One Instrument for All Applications

Each Series 400B Digital Readout uses simple plug-in modules to change to any one of 13 different ranges to measure outputs from thermocouples, RTD's or thermistors. Several models are available which offer pushbutton selection of six different functions.

Quality Makes for Reliability

All printed circuit boards are individually pretested by computer and aged at elevated temperatures for days. Each model is assembled from these pretested boards and assemblies. They are then calibrated, tested and temperature aged again to verify that the design reliability goals have been achieved. This ensures that each unit will perform and will continue to perform to specification and customer satisfaction!

Large, Easy to Read LED Display

All Series 400B Readouts use a large, bright 0.8" (20 mm) LED display that can easily be seen from across a room and from all viewing angles.

°C/°F Switch Selection Without Recalibration

There is no need to play with internal jumpers or to recalibrate when changing between Celsius and Fahrenheit. A "dip switch" easily accessible behind the front panel plexi makes °C/°F conversion a snap.

Laboratory Accuracy

The accuracy of the 400B Readouts is excelled only by expensive, delicate instruments which must be operated in a controlled environment. Instrument accuracy is a combination of the analog-to-digital conversion accuracy, linearization conformity, stability, and resolution. Complete worst-case specifications for all ranges, models and functions are listed.

Thermocouples

Models are available to measure the full temperature range of J, K, T, R, S, B, E, FeCon and CuCon Thermocouples.

RTD's

The 400B family will easily connect to platinum RTD sensors. The platinum sensors can be 3 or 4 wire types with an α of 0.00385 or .00392 and a resistance of 100 ohms at 0°C.

Thermistors

The two versions of Thermistor model are used with the OMEGA Series 700 probe.

Digicator™ Series 400B

Many Models Stocked For Fast Delivery

850
OMEGA
1 2 3 4 5

Model 402B

1° Resolution
°F or °C Switchable
5 point Selector Switch
Choose Range Designation from page M-27
$500

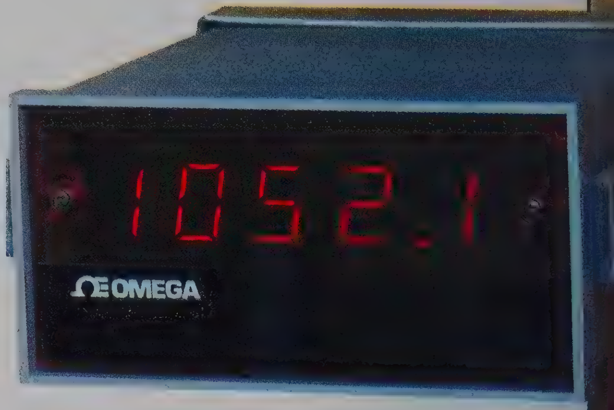
480.1
OMEGA
1 2 3 4 5

Model 412B

0.1° Resolution
°F or °C Switchable
5 point Selector Switch
Choose Range Designation from page M-27
$615

Model 400B

1° Resolution
°F or °C Switchable
Choose Range Designation from page M-27
$380


1052.1
OMEGA

Model 410B

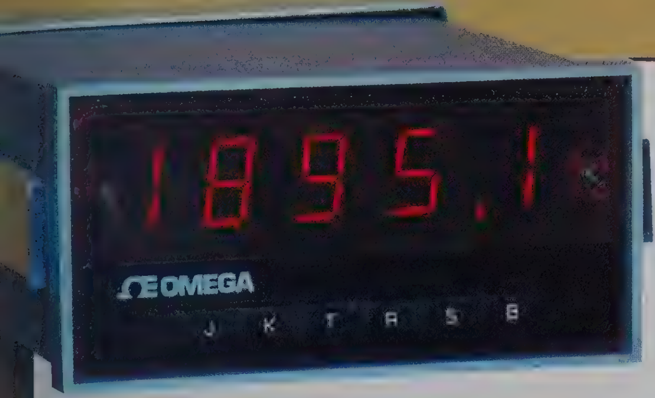
0.1° Resolution
°F or °C Switchable
Choose Range Designation from page M-27
$500

1 2 3 4 5
OMEGA Multipoint Selector 405A
6 7 8 9 10

Model 405B	**Model 409B**
For Thermocouple Inputs	For PT-100 RTD Inputs
$190	**$300**

10 Point Selector Switch

Multiple units can be connected together. Option 001A should be ordered with the Models 400A and 410A when used in conjunction with Models 405B and 409B



1895.1
OMEGA
J K T R S B

Model 403B
1° Resolution
$650

Model 415B
0.1° Resolution
$865

Six Inputs, Switch Selected
°F or °C Resolution
For Thermocouple Types:
J, K, T, R, S, & B.

1588
OMEGA
Power Pack 406
+V
-V
INPUT
LOW
ON
OFF
BATTERY

Model 406

$260

Rechargeable Battery Pack and Carrying Case

Rechargeable batteries with carrying case. Front panel on/off switch and Low Battery Indicator, used with all Models *except* Models 403, 408, 415, and 418 (Multi range Models). Price does not include the indicator.

1040
OMEGA
FeCon
K
CuCon
E
1000mV
Pt100

Model 408B
1° Resolution
$755

Model 418B
0.1° Resolution
$865

Six Inputs, Switch Selected
°F or °C Switchable
For Thermocouple Types:
Fe Con (J), K, Cu Con (T), E, 1000 mV & Pt-100

946.1
OMEGA
Power Pack/Potentiometer 407
+V
-V
INPUT
PUT
LOW
ON
OFF
BATTERY
OUTPUT ADJUST

Model 407

$340

Calibration Potentiometer and Rechargeable Battery Pack with Carrying Case.

An output on the calibrator produces a simulated thermocouple voltage which is measured by both the digital readout and the instrument being calibrated. Output impedance is 10 ohms. The 407 Calibration Potentiometer can be used *only* with thermocouple models.

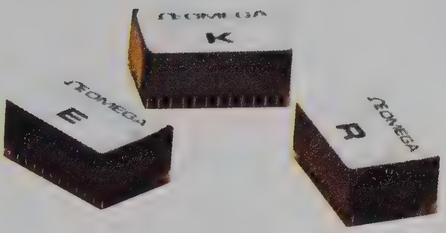
Note: Price of battery pack does not include indicator, which is shown in photograph for relative appearance only.

198.1
OMEGA
Power Pack/Potentiometer 407
BATTERY
OUTPUT ADJ

NEW RANGES AVAILABLE
call sales department

Range Specifications for Series 400B Instruments

Table	Designation	Temperature Range	400B/402B 403B/408B Accuracy (±) 1° Resolution	410B/412B 415B/418B Accuracy (±) 0.1° Resolution
A	**J**	−328 + 1712°F	1°	0.6°
		−200 + 933°C	1°	0.5°
	K	−208 + 2552°F	1.50° Below 0° 1° Above 0°	1.2° Below 0° 0.8° Above 0°
		−133 + 1400°C	1°	0.8° Below 0° 0.5° Above 0°
	T	−328 + 752°F	1°	0.5°
		−200 + 400°C	1°	0.5
	R	+ 32 + 3252°F	3° Below 350° 2° Above 350°	3° Below 350° 1.5° Above 350°
		0 + 1788°C	2°	2° Below 200° 1° Above 200°
	S	+ 32 + 3252°F	3° Below 600° 2° Above 600°	3° Below 600° 1.5° Above 600°
		0 + 1788°C	2°	2° Below 315° 1° Above 315°
	B	912 + 3392°F	4°	2.5°
		489 + 1866°C	2.5°	1°
B	**J DIN**	−200 + 900°C	1°	0.5°
	T DIN	−200 + 600°C	1°	0.4° Below 0° 0.2° Above 0°
	E	−328 + 1952°F	1°	0.7°
		−200 + 1066°C	1°	0.4°
	Pt3 Din = .00385	−388 + 1632°F	1°	0.7° Below −328° 0.4° Above −328°
		−233 + 888°C	1°	0.3° Below −200° 0.2° Above −200°
	Pt4 Din =.00385 (4 wire RTD)	−388 + 1632°F	1°	0.7° Below −328° 0.4° Above −328°
		−233 + 888°C	1°	0.3° Below −200° 0.2° Above −200°
	THF F THF 700 Series thermistor	+ 32 + 212°F	.4° (0.1° res)	.4° (0.01° res)
	THC F THC 700 Series thermistor	0 + 100°C	.2° (0.1° res)	.2° (0.01° res)
	4-20 ma.	0 + 100%	1 count (0.1%)	1 count (0.01%)


OMEGA
K
OMEGA
E
OMEGA
R

Series 400B Ordering Examples

Example #1: 402B-J-F

A Model 402B with 5 push button selector switch to read Type J (Iron-Constantan thermocouples in °F with 1.0° resolution.

$500

Example #2: 410B-K-C

A Model 410B for Type K (Chromel-Alumel) thermocouples to read in °C with 0.1° resolution.

$500

Example #3: 400B-J-F, 1 ea 411A(1)-003A-005A

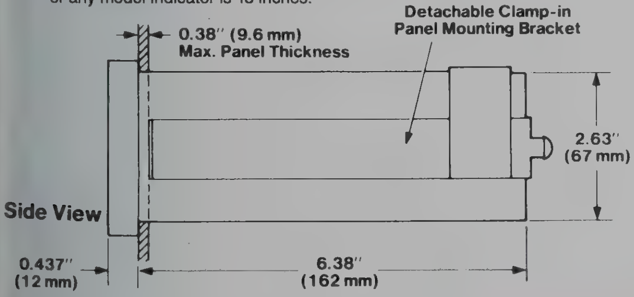
A Model 400B for Type J (Iron-Constantan) thermocouples to read in °F with 1.0° resolution. The 411A(1) is a 411A chassis with one cutout for access to the option 003A Single Limit Digital Setpoint thumbwheels. The Analog Output 005A may be installed in the 400B or 411A chassis.

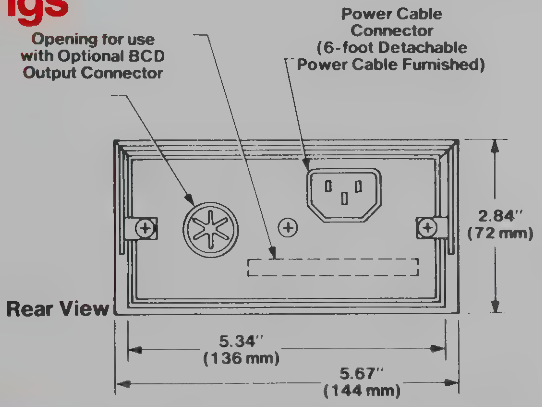
$769

Series 400B Dimensional Drawings

Note: Panel Cutout Dimensions: 2.68″ × 5.44″ (68mm × 138mm). All Model 400B Chassis Have Same Dimensions.

Note: The maximum distance a 411A can be located from either another 411A or any model indicator is 18 inches.


Detachable Clamp-in Panel Mounting Bracket
0.38″ (9.6 mm) Max. Panel Thickness
2.63″ (67 mm)
Side View
0.437″ (12 mm)
6.38″ (162 mm)


Power Cable Connector (6-foot Detachable Power Cable Furnished)
Opening for use with Optional BCD Output Connector
2.84″ (72 mm)
Rear View
5.34″ (136 mm)
5.67″ (144 mm)

EXTENDED RANGES

RANGE DESIGNATOR	TYPE OF INPUT	DISPLAY RANGE	ACCURACY (all ±) 400B	ACCURACY (all ±) 410B
I-1	4-20 mA Transducer Current Transmitter	0 to 100% 400B Resolution 0.1% 410B Resolution 0.01%	1 count	0.01% of reading ± 1 count
I-3	4-20 mA Transducer Current Transmitter	Adjustable Scaling Module 400B Zero: – 1000 to 2000 Span: 100 to 2500 410B Zero: – 10000 to 20000 Span: 1000 to 25000 Max. offset is ± 5 times span	± 5 counts	± 50 counts

Specifications

OMEGA
E
OMEGA
K
OMEGA
J

5100
OMEGA
J
K
T
R
S
B

Specification Common to All Models

Accuracy:
See Range Specifications, page M-27

Resolution:

Range:	400B, 402B, 403B, 408B,	410B, 412B, 415B, 418B
RTD and T/C	1°	0.1°
Thermistor	0.1°	0.01°

Repeatability:
R, S, B Ranges: ±0.2°C or °F
T Range <−200°F: ±0.2°F
All other Ranges: ±1 digit

Stability with Temperature:
Zero: 1μV/°C 400B Models
.5μV/°C 410B Models
Span: 0.01% RDG/°C 400B Models
0.005% RDG/°C 410B Models
Reference Junction: 0.025°/°, 10-40°C base metal types
0.05°/°, 10-40°C noble metal types

Stability with Time: No measurable drift

Noise Rejection:
NMR: >60 dB at 58 Hz, >56 dB at 50 Hz 3 pole, low pass filter with 6 Hz poles
CMR: >120 dB at 58-62 Hz, >110 dB at 50 Hz with 250 ohms unbalance

Operating Range:
Ambient Temperature: 0 to 50°C.
Temperature Rise inside case is 5°C typical
Ambient Humidity: 0-70% at 0-50°C for rated accuracy

Storage Temperature: −40 to +60°C

°C/°F Conversion: Without recalibration

Input Connections: At rear of indicator; four screw terminals on 3/8″ centers.

Power: 100-125V AC or 190-250V AC (jumper selectable), 48-400 Hz, 1.5 watts typical, 4 watts with all segments lit, slightly more when charging battery unit. A 6-foot detachable power cord is supplied.

Display: 0.8″ high LED uniplanar numerals.

Measurement Time: From 3 readings per second at low magnitudes, up to 1.5 seconds per reading at upper limit magnitudes.

Linearization: 100% digital using 42-46 segments, depending on range selected.

Construction: Instrument case of die-cast aluminum with textured vinyl paint.

Overload Protection: 230V DC or V AC without damage, for at least 5 minutes. 115 V DC or V AC continuous.

Reliability: 30,000 hours MTBF

Installation: Panel mounting from the front of the panel and secured at the rear by U-channel supplied with each indicator.

Instrument Size: 72 mm x 144 mm x 173 mm (2.84″ x 5.67″ x 6.82″) Panel cutout of 68 mm x 138 mm (2.68″ x 5.44″)

Weight:
Net: 1.134 kg (2½ lbs)
Shipping: 1.36 kg (3 lbs)

Specifications for Thermocouple Inputs

Open T/C or Break Detection: 30 nanoamp, negative DC, allows parallel connection of most controllers with negligible interaction.

Source Resistance Effect: 1.5 microvolts offset for each 50 ohms of source resistance; removable by screwdriver adjust.

Specifications for RTD Inputs

Sensor Type: 100 ohm platinum at 0°C with alpha of 0.00385 or 0.00392. Unless otherwise specified, 0.00385 alpha will be supplied.

Source Resistance Effect:
PT-100 4-wire range; 0.03°C/Ω offset in +I and −V leads and 0.001°C/Ω offset in +V and −I lead
PT-100 3-wire range: add an additional 2.5°C/Ω unbalance between +I and −V leads. Unbalance can be calibrated out.

Sensor Excitation Current:
100Ω Platinum: 100 microamperes
10Ω Copper: 500 microamperes

Specifications for Thermistor Inputs

Sensor Type: OMEGA Series 700 Probes (See Section F).

Lead Resistance Effect:
Up to 10Ω of resistance in each of the three leads can be calibrated out.

Sensor Excitation: 1 Volt.

Note: °C/°F conversion cannot be accomplished with the fron panel °C/°F switch on the thermistor ranges.

Accuracy Specifications include errors due to linearization, A/D conversion, internal instrument noise, and ±10% line voltage variation at 25±3°C (77±5°F) for 24 hours without zer or scale adjustment. All contributing errors are added togethe to produce worst case instrument accuracy.

Calibrator Options 406 and 407

Input: Two 5-way binding posts on the front of the unit are used as input or output terminals, dependent upon operation. Four 5-way binding posts when used with RTD or thermistor models.

Controls:
Power On/Off Switch: Connects the battery voltage to the indicator.
Low Battery Indicator: An LED indicator will illuminate when battery is low.

Battery: 10V, rechargeable, sealed module, 4 to 8 hours continuous operation per charge, recharge time of 14 hours max. Good for 500 cycles, easily replaced.

Charging: When plugged into an outlet with the power switch in the OFF position, the indicator is operational while the battery is charging.

Size with 400B Indicator:
144 mm x 144 mm x 200 mm (5.67″ x 5.67″ x 7.87″)

Weight:
Net Weight: 3.636 kg (8 lbs)
Shipping Weight: 4.08 kg (9 lbs).

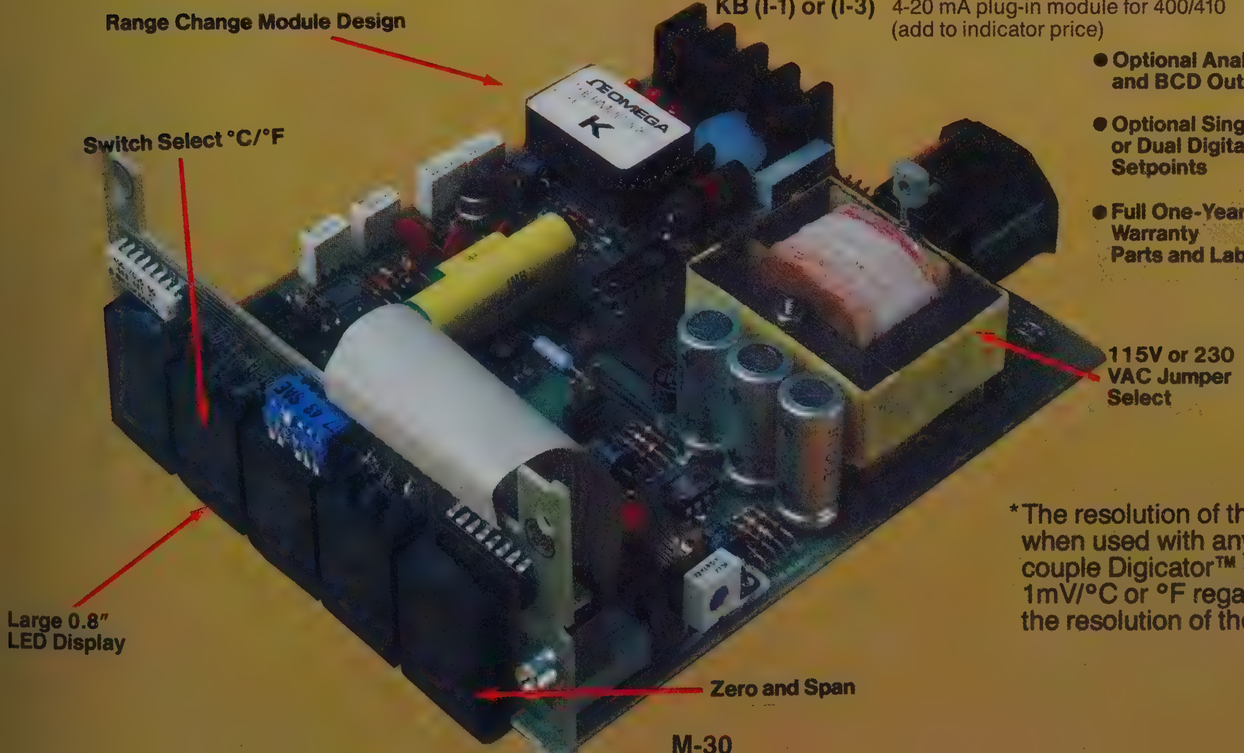
407 Calibrator Controls:
Fine: A 1-turn potentiometer and switch that turns the calibration circuitry on and adjusts output to within 0.1°, as shown on the indicator. Models read out directly in degrees.
Coarse: A 10-turn potentiometer to adjust output to within the range of the Fine control.

Options and Accessories

Part No.	Description	Price
001A	**Switching Error Indication:** Option 001A is used in models 400 and 410 only when one or more model 405A or 409A switch assembly is required. Causes blanking of display in the event that more than one button is depressed.	$49
002A	**BCD Output:** Option 002A is a field installable PC board. It provides a BCD output that is equivalent to the magnitude of the data displayed. This output is isolated and buffered. Each output line is capable of driving two TTL loads (1.6mA each). Input command lines are CMOS and TTL compatible and consist of: data request, continuous output and hold. Data Output: BCD CMOS DTL/TTL compatible. Coding: 8-4-2-1 BCD positive true. Single bit for overload and polarity. Logic Level: "0" .4V MAX "1" 2.5V MIN	$165
003A	**High or Low Limits Digital Setpoint Option:** Option 003A is a field installable PC board that offers a single limit, manual or automatic reset comparator. Five thumbwheel switches allow for the setting of a high or low limit from −3999 to +3999. A switch at the rear of the board allows for selecting automatic or manual reset. Manual reset is accomplished by an external contact closure. Option 003A uses completely isolated 0.5A, 115V AC Form C contact closures. When a limit is reached, the relay closes and a LED lamp is illuminated.	$170
004A	**High or Low Limits Digital Setpoint with "Dead Band"** Option 004A is the same as 003A but with a "hysteresis" or "dead band" for two position on/off operation. The "dead band" is adjustable from 0 to −9. This is particularly useful on applications to minimize excess operation of contacts with normal process fluctuations. Two options 003A/004A may be combined with Model 411A option chassis for dual digital setpoints.	$265
005A	**Analog Output** This field installable PC board provides an analog output voltage of 1 mV per °C or °F* (1 mV/0.1°C or °F for thermistor ranges.) The output is completely isolated at the rear screw terminals with automatic polarity sensing. Output: 1 mV/°C or °F isolated Accuracy: ±0.25% of reading Impedance: 5K ohm	$170
005A-5161	Analog option with .1° Resolution. Limited to 400°F or °C	$320
411A	Chassis for 003A, 004A or 005A Option boards. Specify 0, 1 or 2 front panel cutouts.	$49
407-4200-00	Replacement rechargeable battery module for 406/407.	$71
K-400 Blank Case	For mounting any two digital units, one on top of the other.	$65
W5	Tilt stand with rubber feet for indicator.	$49
W6	19" Rack Mount Adaptor for 1, 2, or 3 units. (Specify number of cutouts required.)	$46

Plug-In Modules for Range Change

KA ( )	Range change module (specify type; i.e.: J, K, T, R, S, B)	$54
KB ( )	Range change module (specify type; i.e.: FeCon, CuCon, E, PT3, PT4)	$54
K7500	Spare LSI Chip for Table A ranges	$110
K7501	Spare LSI Chip for Table B ranges	$110
K7502	LSI Chip replaces K7500 and K7501 except in type R, S, B and multirange units 403/415	$110
KB (THF)	Thermistor plug-in module °F for 400/410 (add to indicator price)	$80
KB (THC)	Thermistor plug-in module °C for 400/410 (add to indicator price)	$80
KB (I-1) or (I-3)	4-20 mA plug-in module for 400/410 (add to indicator price)	$92



- Optional Analog and BCD Output
- Optional Single or Dual Digital Setpoints
- Full One-Year Warranty Parts and Labor

*The resolution of the 005A when used with any Thermocouple Digicator™ is fixed at 1mV/°C or °F regardless of the resolution of the display.

MODEL 199
Thermocouple and RTD

T COPPER CONSTANTAN
+332°C
OMEGA ENGINEERING MODEL 199
RTD PLATINUM
1473°C
OMEGA ENGINEERING MODEL 199
K CHROMEL ALUMEL
+1260°F
OMEGA ENGINEERING MODEL 199
OMEGA
-160° to 400° C
OMEGA P/N
-50° to 1990° F
Temp µVolts Adjust

Calibrations:

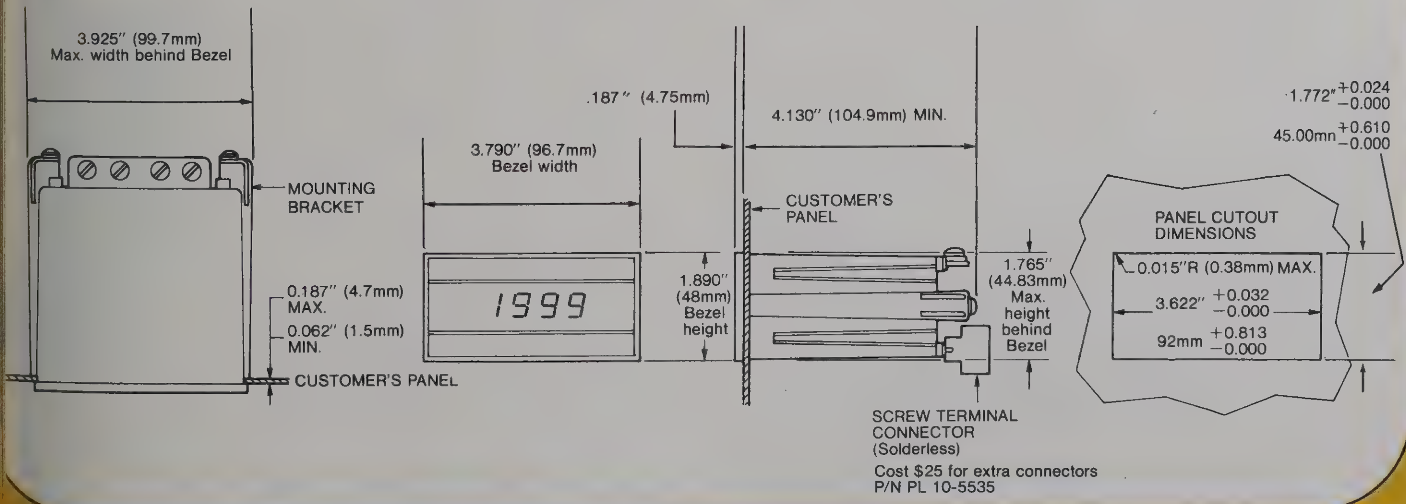
- Iron-Constantan
- Chromel-Alumel
- Copper-Constantan
- Chromel-Constantan
- Platinum-Rhodium
- Platinum RTD
  0.1° and 1.0°
  Resolution Models

Prices start at $26

recision Digital Thermometers

Sensor Type	Material Type	Range	Overall Error	Resolution	Model	Price
J	**Iron/Constantan** (Iron vs. Copper Nickel)	−180° to 760°C −170° to 1400°F	±1.5°C ±1.5°F	1°C 1°F	199JC 199JF	$265.
K	**Chromel/Alumel** (Nickel-Chromium vs. Nickel-Aluminum)	−50° to 1250°C −50° to 1999°F	±2.1°C ±2.5°F	1°C 1°F	199KC 199KF	$265.
T	**Copper/Constantan** (Copper vs. Copper Nickel)	−150° to 400°C −245° to 750°F	±1.5°C ±2.5°F	1°C 1°F	199TC 199TF	$265.
E	**Chromel-Constantan** (Nickel Chromium vs. Copper-Nickel)	−95° to 840°C −75° to 1440°F	±2.1°C ±2.5°F	1°C 1°F	199EC 199EF	$265.
R	**Platinum 13% Rhodium vs. Platinum**	300° to 1750°C	±2.5°C	1°C	199RC	$265.
S	**Platinum 10% Rhodium vs. Platinum**	335° to 1750°C	±2.3°C	1°C	199SC	$265.
B	**Platinum 6% Rhodium** **vs.** **Platinum 30% Rhodium**	745° to 1820°C	±1.9°C	1°C	199BC	$265.
RTD	**Platinum-100 ohm RTD** Alpha = .00385 ohms/°C DIN 43760	−200 to 800°C * −328 to 1492°F*	±1.4°C ±1.9°F	1° °C or °F	199P1	$275.
		−170.0 to 199.9°C* −170.0 to 199.9°F*	±0.2°C ±0.2°F	0.1° °C or °F	199P2	$305.
N	**Nisil** **Nicrosil**	−15° to 1300°C	±2.1°C	1°C	199A	$257

*Switch selectable for °C or °F, supplied with two optical filters.


3.925″ (99.7mm)
Max. width behind Bezel
MOUNTING BRACKET
0.187″ (4.7mm) MAX.
0.062″ (1.5mm) MIN.
CUSTOMER'S PANEL
3.790″ (96.7mm)
Bezel width
1999
.187″ (4.75mm)
1.890″ (48mm) Bezel height
4.130″ (104.9mm) MIN.
CUSTOMER'S PANEL
1.765″ (44.83mm) Max. height behind Bezel
SCREW TERMINAL CONNECTOR (Solderless)
Cost $25 for extra connectors
P/N PL 10-5535
1.772″ +0.024 −0.000
45.00mn +0.610 −0.000
PANEL CUTOUT DIMENSIONS
0.015″R (0.38mm) MAX.
3.622″ +0.032 −0.000
92mm +0.813 −0.000

Features

Thermocouple Models

11 ranges, from −180°C to +1820°C (or −245°F to +1999°F) with seven standard thermocouples. Unique PSM programming — low-cost plug range module.

Automatic polarity indication, cold-junction compensation, unique linearization, open-thermocouple indication, and shorted-couple-to-AC protection.

Very high input impedance (100 megohms) for negligible lead-length error. Readout resolution of 0.05% (±3½ digits, ±2000 counts), less than ±1°F conformity error.

OMEGA
K CHROMEL ALUMEL
+1260 F
POWER
OMEGA ENGINEERING MODEL 199

RTD Models

2 models: 1.0°, 0.1° resolution — switchable for either °C or °F readings.

High accuracy; 1 digit ±0.05% reading. Achieved through multi-segment linearization.

For use with either 3 or 4 wire, 100 ohm platinum RTD sensor.

Automatic external lead wire compensation — up to 100 ohms.

All Models

Exclusive dual automatic zero design assures highest repeatability ever in a 2000-count design. 1400-volt thermocouple isolation (input to power ground). CMRR greater than 130dB. Two-pole filter for very fast response, with more than 100dB NMRR.

Big, bright, high-contrast planar LED display for maximum readability.

Virtually immune to AC line noise and fluctuations, shock, vibration stresses, and temperature and humidity variations.

Latched and buffered parallel BCD outputs available for interfacing to printers, set-point controllers, data loggers, or mini-computers. Includes TEST, HOLD, BLANK, PRINT-COMMAND lines.

Buffered and linearized analog output available for recorders, controllers, and remote readouts.

Screw-terminal connector available for fast, solderless wiring.

Comprehensive test and quality-assurance procedures ensure lasting reliability, one-year recalibration rating.

OMEGA'S Model 199 — A great value in digital thermometry for industry

Every characteristic and feature of the Model 199 marks as a true industrial-grade design . . . from the shock-resista optional all-metal, sealed, shielded case to the high-performance input and line filtering and 1400 volt isolation c the input circuit. The design is specifically rated to maintain stability and calibration longevity over very wide temperatur and humidity ranges, and the accuracy is virtually unaffecte by ground-loop and other common-mode signals, up to very high noise and CMV levels.

Perhaps the most impressive aspect of this advanced instrument is its flexibility. Eleven thermocouple models accommodate the N.B.S. certifiable ranges of each one of th seven thermocouples — providing both °C and °F calibratio for most thermocouple types.

Each thermocouple range is linearized to within ±1 degree (with respect to theoretical) with effective cold junction compensation for each model and most remarkabl of all — all thermocouple ranges are programmed, simply by plugging a small module into the instrument's main circuit card.

Superior accuracy is the hallmark of the two companion platinum RTD models — high accuracies achieved through multi-segment linearization — accuracies equal or better than ±0.05% of reading ±1 digit for both the 0.1° and 1.0° models. And each model can display temperature in both °C and °F. Simply flip a switch under the lens to make the change.

Linearization to the world-wide accepted DIN 43760 curv (alpha=.00385) assures the user availability of matching sensors both here and abroad from OMEGA as well as other manufacturers. Automatic lead wire compensation is built into each unit to eliminate the effect of lead wire resistance - resistance up to 100 ohms, five to ten times the rating of comparably priced instruments. Most surprising of all the RTD models can be used with either 3 wire or 4 wire RTD sensors, a feature normally found only in instruments costin much, much more.

Sensor flexibility and accuracy are only two facets of the Model 199 capabilities. This remarkably versatile design accommodates a very broad range of output data/control/status interfaces. This includes a unique buffered high-level analog output option, for recorders, set-point controllers, and remote meters. It also includes an optional instrument-grade buffered, latched, parallel BCD output for printers, digital set-point control computers, intelligent terminals, or telemetry. And there is also a full complement of status, control, and system-timing signals, fo ease of system integration.

Quality control standards include the use of premium components throughout, 100-hour burn-in cycling of 100% c production, and computer-automated testing. And all of this quality is provided in a digital thermometer costing much les than the price of inferior, limited performance instrumentation!

Specifications

Thermocouple Input

nput Impedance	100M Ω nominal (Referenced to analog ground)
Lead Resistance Effect	20 μ V per 350 ohms
Cold-Junction Compensation	Automatic, ±0.03°C/°C from +10°C to +40°C
Thermocouple Burnout	Same indication as OVERRANGE. (See Below)
Thermocouple Short to AC Line	No effect, automatically protected by built-in circuits to 300V peak, 200V RMS.
Maximum Common Mode Voltage	1400 volts DC or AC peak with respect to power ground.
Common Mode Rejection Ratio	>130dB, AC power to signal low with 250 ohms unbalance
Normal Mode Rejection Ratio	>100dB @ 50/60Hz

RTD Input

Type	100 ohm platinum (PT 100) per DIN 43760 (α=0.00385)
Configuration	User selectable 3 wire or 4 wire
Excitation Current	1 mA nominal
External Lead Resistance Effect	Automatic compensation for up to 100 ohms maximum
RTD Short to AC Line	No effect, automatically protected by built-in circuits for up to 180 V peak 130 V RMS.
Maximum Common Mode Voltage	1400 volts DC or AC peak
Common Mode Rejection Ratio	100 dB AC power to RTD input
Normal Mode Rejection Ratio	50 dB @ 50/60 Hz
Range Tempco	70 ppm/°C typical 100 ppm/°C maximum

Display

Type	Seven segment planar LED, red, 0.43″ (11mm) high
Polarity Indication	Automatic plus "+" or "−" sign displayed
OVERRANGE ndication	All digits blanked to prevent erroneous readout, "+" or "−" sign remain on.

Analog to Digital Conversion

Technique	Dual slope, six-phase conversion with automatic zero correction, complete conversion each cycle.
Rate	2.5 conversions per second nominal, internally triggered.

Digital Outputs
(option)

Parallel BCD	15 parallel lines provide latched and buffered BCD output, POLARITY, and PRINT command. All are TTL/DTL and CMOS compatible, 2TTL loads each.

Analog Output
(option)

Voltage	1 mV/count linearized and buffered (Referenced to Analog ground)
Current	2mA drive capability, short circuit protected
Common-Mode Voltage	1400 Volts DC or AC peak between output and power line ground
Tempco	10μV/°C maximum

RTD PLATINUM
1473°C
OMEGA ENGINEERING
MODEL 199

Power Choice

110 VAC RMS ±20%, 47 to 500 Hz @ 1.6 Watts nominal (88 to 132 VAC input range)

220 VAC RMS ±20%, 47 to 500 Hz @ 1.6 Watts nominal (176 to 264 VAC input range)

+5 VDC ±5% at 170 MA nominal
+8 to 28 VDC at 90 MA nominal

Environmental & Physical

Operating Temperature Range	−10°C to +50°C(+14°F to + 122°F)
Storage Temperature Range	−40°C to +85°C(−40°F to +185°F)
Relative Humidity	0 to 90%, noncondensing
Weight	11 oz. (312 grams) nominal, AC powered
Case	DIN/NEMA standard, high impact molded plastic case, UL 94V-0 rated. Metal case available.
Mounting	Slide bracket supplied

E CHROMEL CONSTANTAN
352 °C
OMEGA ENGINEERING MODEL 199
J IRON CONSTANTAN
°F
°C
°F
OPTIONAL SOLDER CONNECTOR

Options and Accessorie

Models	Description	Pric
199□□	Digital Thermocouple Thermometer with changeable range module, plastic case, screw terminal connector, 110VAC, 50-60Hz. □ — Specify thermocouple type (J,K,T,E,R,S,B). □ — Specify read-out to be °F or °C. Note R, S, & B only available in °C.	$265
199P1	Digital RTD Thermometer 1.0° resolution, switchable °C or °F, plastic case, screw terminal connector, 110VAC, 50-60Hz.	$275
199P2	Digital RTD Thermometer. Same features as 199P1 except 0.1° resolution.	$305

Output Options

"A"*	Analog linearized output 1 mv per degree (C or F) for one degree models, 1 mv per 0.1 degree (C or F) for 0.1 degree model. *Not field installable.*	$ 30
"D"*	Digital BCD output Parallel, latched and buffered. *Not field installable.*	$ 30

Power Options

110VAC	Unless otherwise specified, Digital will be supplied for 110VAC, 50-60Hz service.	N/
220VAC	Specify "220VAC"	$ 1
5DC	Specify "5VDC"	N/
8-28VDC*	Specify "8-28VDC"	$ 2
Power Cord	3 wire power cord with 3 prong, 110VAC plug, 6 ft. long.	$
PL10-5535	Spare Connector (screw terminals)	$ 2

Additional Options

Metal Case	Fully enclosed and shielded DIN/NEMA panel mount metal case. Specify "metal case".	$ 3
Bench Stand/ Tray	Specify "BST"	$ 1

Extra Range Modules

9□□	Plug in thermocouple range module. Field installable. (Includes new faceplate)

Range Module Selection Guide

Thermocouple Type	Part No. °F	Part No. °C	Price*
K	9KF	9KC	**$28**
J	9JF	9JC	
T	9TF	9TC	
E	9EF	9EC	*Faceplate included
R		9RC	
S		9SC	
B		9BC	
N		9NC	

Ordering Examples

a) Model 199 JF-A-D

Type "J" T/C Instrument with °F readout	$265
Analog Output Option	60
Digital BCD Option	65
Unit supplied in plastic case; uses 110 VAC power	$ 390 Tota

b) Model 199 KC, Metal Case, 220 VAC

Type "K" T/C Instrument with °C readout	$265
Metal Case Option	30
220 VAC Power Option	10
	$ 305 Tota

*If the DC Source used with this option is grounded, the thermocouple must be ungrounded. This restriction does not apply if the DC Source is not grounded.

*A and D options require ungrounded input.

Expanded Family of Model 199 DS Portable Digital Pyrometers

J IRON CONSTANTAN
1250 °F
MODEL 199
OMEGA
OFF
ON
10
1
2
3
4
5
6
7
8
9

LED Display

T COPPER CONSTANTAN
- 225 °F
MODEL 199
OMEGA
POWER
OMEGA

LED Display

Available for Immediate Delivery

tures:

- alibrations available for use with all ANSI ase Metal and Noble Metal Thermocouples
- esolutions of 1 and 0.1 degrees C and F
- ingle and ten channel models available
- 00 Ohm platinum RTD models available
- C powered and rechargeable battery pack nodels available

America's best selling digital panel thermometer, the OMEGA Model 199, is now available mounted in a heavy duty bench case. Two power options — AC line power and internal rechargeable battery packs are available. Four different models are available to suit individual requirements. See following page for additional information on options available as well as pricing

prices start at **$325**

Bench Thermometers

K CHROMEL ALUMEL
1250 F
OMEGA ENGINEERING MODEL 199
ON
OMEGA
RTD PLATINUM 100 Ω α = .00385
147.3 °C
POWER
OMEGA ENGINEERING MODEL 199
LINE
Made in U.S.A.
110/220 VAC 50/60 HZ
9.8 VDC 120 MA
110
220
POS (+)
NEG (−)
AGX
CHARGER INPUT
OMEGA

See Pages **M-31 to M-35** for specifications and ranges.

Model DS-199 Digital Thermometer

The Model DS-199 Digital Thermometer has a single input and is available in Thermocouple Types J, K, T, E, R, S and B and Platinum RTD (α = .00385) in °F and °C. Ranges and specifications are the same as the Model 199. Standard features are 120 Vac power, ON/OFF switch, power cord, and compensated female thermocouple or RTD connector. Analog output and BCD output options are also available.

To order, specify the DS Option followed by the Model 199 with preferred options.

Base Price: Thermocouple Models: **$325**
RTD Models: DS-199-P1 **$335**
DS-199-P2 **$365**

Model DSS-199 Digital Thermometer

The DSS-199 Digital Thermometer is the same basic instrument as the DS-199, but with additional capability for monitoring up to 10 thermocouples of the same type or 10 platinum RTD's. Channel selection is by a 10-position front pane rotary switch. Inputs are 10-position terminal blocks, 2 for Thermocouple models and 3 for RTD models.

To order, specify the DSS Option followed by the Model 199 with preferred options.

Base Price: Thermocouple Models: **$390**
RTD Models: DSS-199-P1 **$400**
DSS-199-P2 **$430**

Model DS-01-199 Digital Thermometer

The DS-01-199 Digital Thermometer is the same basic singl input instrument as the DS-199, but is portable by the addition of an internal Ni-Cad battery pack. The battery pack wi operate the instrument for up to 8 hours of continuous use. The charger (supplied) is a dual-voltage 115/230 Vac charge and will recharge the batteries overnight (18 hours) or supply continuous power to operate the instrument directly fro AC power. The DS-01-199 is available in both Thermocoupl and RTD models.

To order, specify the DS-01 Option followed by the Model 199 with preferred options.

Base Price: Thermocouple Models: **$460**
RTD Models: DS-01-199-P1 **$470**
DS-01-199-P2 **$500**

Model DSS-01-199

The Model DSS-01-199 Digital Thermometer is the same ba 10-channel instrument as the DSS-199, but is portable by th addition of an internal Ni-Cad battery pac The battery pack will operate the instrum for up to 8 hours of continuous use. The charger (supplied) is a dual-voltage 115/2 Vac charger, and will recharge the batteri overnight (18 hours) or supply continuou power to operate the instrument directly from AC power. The DSS-01-199 is availa only in Thermocouple models.

To order, specify the DSS-01 Option follo by the Model 199 with preferred options.

Base Price: $525
(Includes (8-28 Vdc) meter option)

Ordering Instructions:

DS
DSS
DS-01
DSS-01
-199 - ☐ - ☐ - ☐ - ☐

Digital Output (extra cost)
Analog Output (A) (extra cost)
°F or °C Readout
Thermocouple Type or P1 or P2 for RT

Example:
DS-199-KF-A
This is a Type K Model 199 with °F read out and analog output in the single-input DS package. Price $355

Digital Thermometers
Model 115

NEW!

$189
Each

THERMOCOUPLE THERMOMETER
115 °C
MODEL 115 JC
OMEGA ENGINEERING, INC.
THERMOCOUPLE THERMOMETER
1600 °F
OMEGA ENGINEERING, INC.
MODEL 115 KF
OMEGA

Probe Not Included

- Rugged DIN/NEMA Case
- Cold Junction Compensated
- Linear Analog Output for Chart Recorders

Precision at an Affordable Price

THERMOCOUPLE THERMOMETER
1600 °F
OMEGA ENGINEERING, INC.
MODEL 115 KF

Special High Volume Discounts Available
Consult Sales Department

Digital Thermometers
Model 115

115 DIGITAL THERMOMETER
OMEGA
ANALOG OUTPUT
240 VAC
117 VAC
CHROMEL
ALUMEL
OMEGA

**Analog Output
Standard**

Probe Not Include

$189 **NEW!**
Each

ANSI Type Thermocouple	Material Type	Range	Readout Accuracy	Resolution	Model
J	**Iron/Constantan** (Iron vs. Copper Nickel)	−100° to 760°C	±2.0°C	1°C	115 JC
		−100° to 1400°F	±3.6°F	1°F	115 JF
K	**Chromel/Alumel** (Nickel-Chromium vs. Nickel-Aluminum)	− 50° to 1200°C	±2.6°C	1°C	115 KC
		− 50° to 1999°F	±4.7°F	1°F	115 KF
T	**Copper/Constantan** (Copper vs. Copper Nickel)	−100° to 400°C	±2.0°C	1°C	115 TC
		−100° to 750°F	±3.6°F	1°F	115 TF
E	**Chromel/Constantan** (Nickel Chromium vs. Copper-Nickel)	− 50° to 800°C	±2.6°C	1°C	115 EC
		− 50° to 1500°F	±4.7°F	1°F	115 EF

Off-The-Shelf Delivery **$189 All Models**

THERMOCOUPLE THERMOMETER
1600 F
OMEGA
MODEL 115
OFF
ON
OMEGA

Bench Top Style

Model DS-115 Digital Thermometer

The Model DS-115 Digital Thermometer has a single input and is available in Thermocouple Types J, K, T and E in °F and °C. Ranges and specifications are the same as the Model 115. Standard features are 120 V ac power, ON/OFF switch, power cord, and compensated female thermocouple connector.
To order, specify the DS Option followed by the Model 115 with preferred options.
Price: **$249**

Model DSS-115 Digital Thermometer

The DSS-115 Digital Thermometer is the same basic instrument as the DS-115, but with additional capability for monitoring up to 10 thermocouples of the same type. Channel selection is by a 10-position front panel rotary switch. Inputs are 10-position terminal blocks.
To order, specify the DSS Option followed by the Model 115 with preferred options.
Price: **$314**

Specifications

Thermocouple Types: J, K, T, and E
Cold Junction Compensation: 0.05°F/°F (0.05°C/°C) ambient of 32 to 104°F (0 to 40°C)
Input Impedance: Greater than one megohm
Input Current: 10 nA
Open Thermocouple: Plus or minus over-range, +1xxx or −1xxx (X = blank)
Common Mode Rejection Ratio: 120 dB
Common Mode Voltage: 240 RMS max

Accuracy
Resolution: 1°C or 1°F
Readout Accuracy: See Table (25°C Ambient)
Output Accuracy: ±0.5% span

Electrical and Physical
Operating Voltage: 117 V ac or 230 V ac ±15%, 50 or 60 HZ
Power Consumption: 1.75 Watts
Operating Temperature: 32 to 104°F (0-40°C)
Storage Temperature: 14 to 122°F (−10 to +50°C)
Output: Analog, 1 mV/°C or 0.556 mV/°F (0°F = 0 mV). Analog device must have input impedance of 10 k Ω
Display: 0.56 inch high LED
Dimensions: H: 1.9″ (48 mm) × W: 3.8″ (97 mm) × D: 4.13″ (105 mm) DIN/NEMA standard
Weight: 12.35 oz (350 g)

How to Order

1. SPECIFY MODEL NUMBER
2. SELECT THERMOCOUPLE FROM OMEGA TEMPERATURE MEASUREMENT HANDBOOK.

Discount Schedule

1-9	$189.00
10-24	170.00
25-49	150.00
50-99	130.00

OMEGA PROBE SELECTOR GUIDE

Call our knowledgeable Sales Department for more information.
Custom probes manufactured to your specifications. Send a sketch for a quote.

(203) 359-1660

Type	Size	Calibration	Temperature Range	Sheath Material	Typical Applications	Handbook Location
Weld Pad	Weld Pad 1″ × 3/4″ × 1/8″	J, K, T, E	to 500°F	Inconel or Stainless Steel	Industrial applications requiring a permanent installation	B-5
Terminal Block	1/16, 1/8, 3/16, or 1/4″	J, K, T, E, RTD	to 425°F (RTD to 1112°F)	Inconel or Stainless Steel	Quick hook up for direct immersion or for use in thermowells	A-11
Penetration	3/16″ Diameter	J, K, T, E, RTD	to 1700°F (RTD to 1112°F	Stainless Steel	Conical tip for easy insertion into semi-frozen meat as well as molten plastics	A-4, D-4, E-3, E-4, F-3
Air	3/16″ Diameter	J, K, T, E, RTD	to 500°F	Stainless Steel	For fast ambient temperature measurements. Works well in air ducts	A-4, D-4, E-3, E-4
Surface Probes	1/4″ Diameter	J, K, T, E, RTD	to 500°F (RTD to 482°F)	Stainless Steel	Flexible tip conforms to most difficult surfaces	A-4, D-4, E-3, E-4, F-3
Integral Handle Probes	3/16″ Diameter	J, K, T, E, RTD	to 1700°F (RTD to 1112°F)	Stainless Steel	For hand held gas, air, or immersion measurements	A-5, A-6, D-5, E-4
Quick Disconnect Probes	3/16″ Diameter	J, K, T, E, RTD	to 1700°F (RTD to 1112°F)	Stainless Steel	For hand held gas, air, or immersion measurements	A-3, A-4, D-6, E-3, F-13
Head & Well Assemblies	will accommodate various probes	will accommodate various probes	up to 3000°F for Ceramic	Brass, Carbon Steel, Monel, Stainless Steel, or Ceramic	Heavy duty industrial use and for insertion into hazardous environments	B-15 to B-36
High Temperature w/Ceramic Tube	1/4″ or 3/8″ protection tube O.D.	R, S, or B Platinum Thermocouple	to 3000°F	High Temperature Ceramic	Oxidixing or reducing atmospheres up to 3000°F	B-6
Laboratory Probes	3/16″ Diameter	Thermistor	to 150°C	Polyvinyl	High precision, low temperture	F-3 to F-14

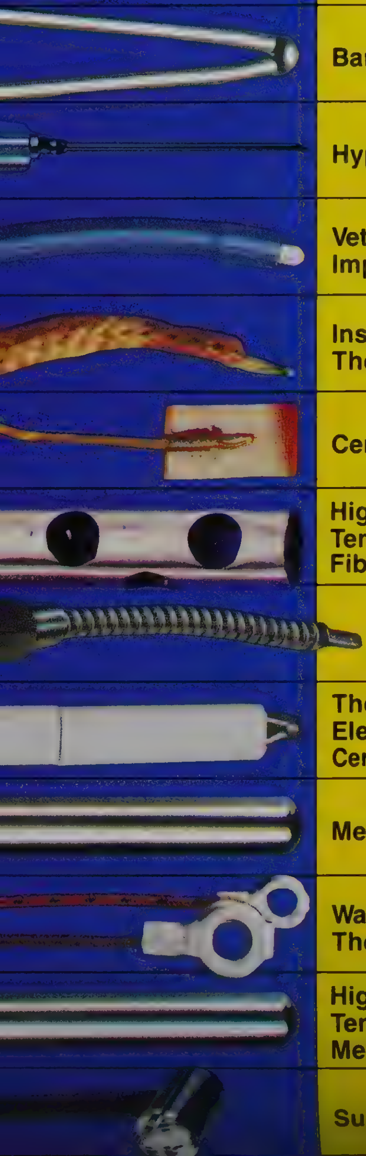
OMEGA ENGINEERING, INC. One Omega Drive, Box 4047, Stamford, CT 06907 Telex 996404 Cable OMEGA FAX (203) 359-7700

PROBE SELECTOR GUIDE

OMEGA

Call our knowledgeable Sales Department for more information.
Custom probes manufactured to your specifications. Send a sketch for a quote.

(203) 359-1660



Type	Size	Calibration	Temperature Range	Insulation	Typical Applications	Handbook Location
Bare Wire	0.0005″ to 0.032″ Diameter	—	−450° to 4200°F	None	Biophysics, medical research, chemical reactions	**A-23, A-24**
Hypodermic	0.008″ to 0.072″ Diameter	J, K, T, E, Platinum RTD	Autoclavable to 350°F	Stainless Steel Needle	Natural sciences, food processing, chemical research	**A-18 to A-20**
Veterinary Implantation	0.213″ O.D. × 0.188″	T, RTD, Thermistor	−100° to 180°F	Polyurethane	Veterinary research	**A-21**
Insulated Thermocouple	0.005″ to 0.032″ Diameter	J, K, T, E	to 400°F	Glass Fiber or Teflon	Gas, liquid, or surface temperatures	**A-27**
Cement-on	0.0005″ foil and 0.010 wire	J, K, T, E	to 425°C continuous	Polymer/glass Laminate	Flat or curved metal, glass, plastic surfaces	**A-28**
High Temperature Fiber Insulated	20 gage	K	to 1800°F continuous	Nextel with Inconel Overbraid	Profiling ovens and furnaces	**A-16**
Plastic Extruder	—	J, K, T, E	400° to 950°F	—	Mounts directly in extruder head or die adaptors	**A-30 to A-33**
Thermocouple Elements of Ceramic Insulators	8 to 21 gage	J, K, T, E—	to 2300°F	Ceramic Bead	Scientific instruments, metal cutting research, gas chromatography	**B-11 to B-14**
		R, S, B—	to 3000°F			
Metal Sheath	0.010″ to 0.250″ Diameter	J, K, T, E, R, S, B, RTD	to 2100°F	MgO with SS or Inconel Sheath	General purpose for air, gas, or immersion.	**A-3 to A-11, E-3 to E-8**
Washer Thermocouple	#8, #10, & ¼″ screws	J, K, T, E	to 900°F	Glass Fiber	Mount to flat surfaces or inside ovens	**A-25**
High Temperature Metal Sheath	.020″ to 0.250″ Diameter	R, S, B, G, C, D	to 4200°F	Various Ceramics	High temperature ovens, molten steel, refineries	**A-13, A-14**
Surface Probes	0.006″	J, K, T, E	to 2000°F	Various	Any surface measurement of plastics, ceramics, or metals	**D-7 to D-9**

Panel Mount Scanner
Model MDP-8

NEW!

- THERMOCOUPLES
- RTD's
- THERMISTORS
- SIGNAL VOLTAGES

The MDP-8 Multiplexer is an eight channel scanner that provides a low cost front-end for multipoint alarm or display systems. Up to 16 units can be series connected to switch 128 two wire circuits. Modules can also be operated in parallel to switch 3 and 4 wire circuits. Front panel slide switches allow the operator to skip unused channels or hold on a single channel of interest. The nominal dwell time on each channel is two seconds.

MDP-8
SCANNER
1
2
3
4
5
6
7
8
SCAN
HOLD
OMEGA
ENGINEERING, INC.

MDP-8 $310

Fits in a Standard DIN/NEMA Cutout.

Works With Digital Readout

THERMOCOUPLE THERMOMETER
1492 °F
MODEL 115 KF
OMEGA
ENGINEERING, INC.

Model 115 Shown
$189

CONNECTS TO ALARMS—COMPUTERS—DIGITAL READOUTS

Miniature Scanner

SPECIFICATIONS

NUMBER OF CHANNELS: 8 double pole channels per unit.

SWITCHING: Reed relay.

CONTACT RESISTANCE: 0.2 ohm max.

MAXIMUM INPUT VOLTAGE: (switched or common mode) 200 V.

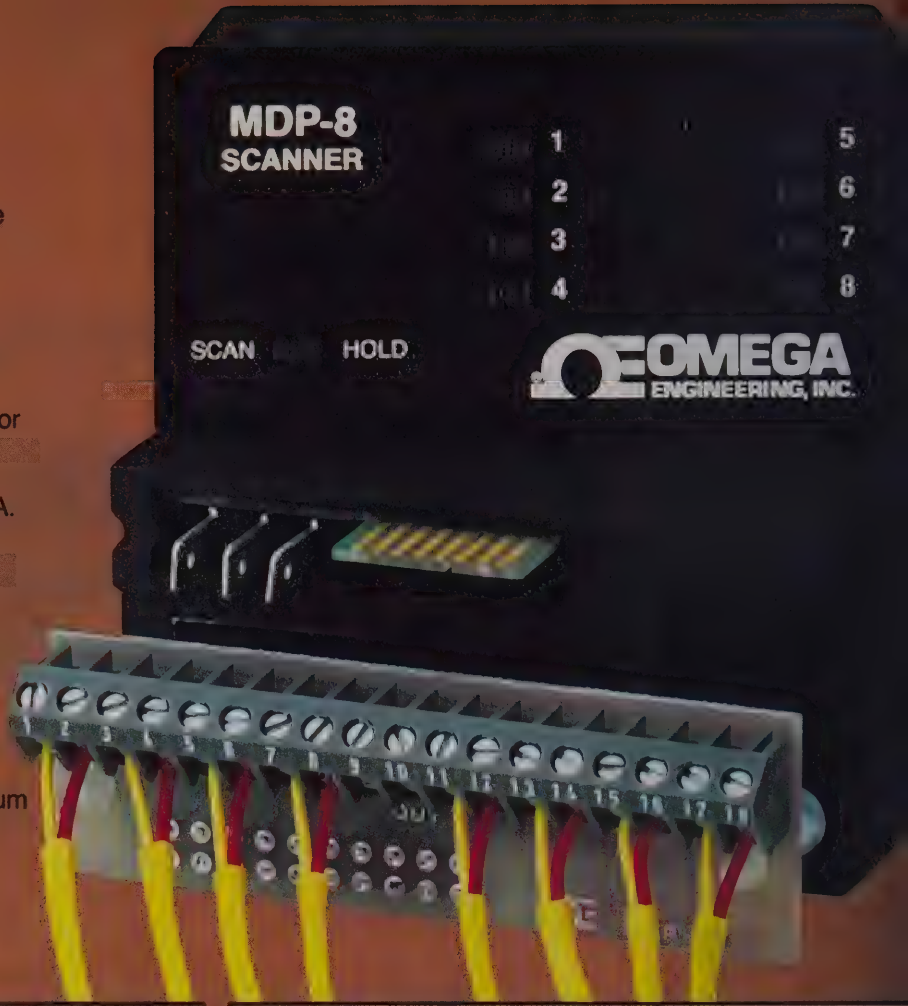
MAXIMUM CURRENT SWITCHED: 0.5 A.

MAXIMUM POWER SWITCHED: 10 W.

POWER SUPPLY VOLTAGE:
5 VDC
8-40 VDC
110 VAC +/− 20%, 50-60 Hz.
220 VAC +/− 20%, 50-60 Hz.

POWER CONSUMPTION: 1.8 W maximum per unit.

CUTOUT DIMENSIONS: H = 1.711″
W = 3.622″
D = 4″



POWER OPTIONS

110 VAC ± 20%	STANDARD
220 VAC ± 20%	ADD $25
+5 VAC	ADD $10
8 to 40 VDC	ADD $25

Specify Power Option After Model Number

TO ORDER:

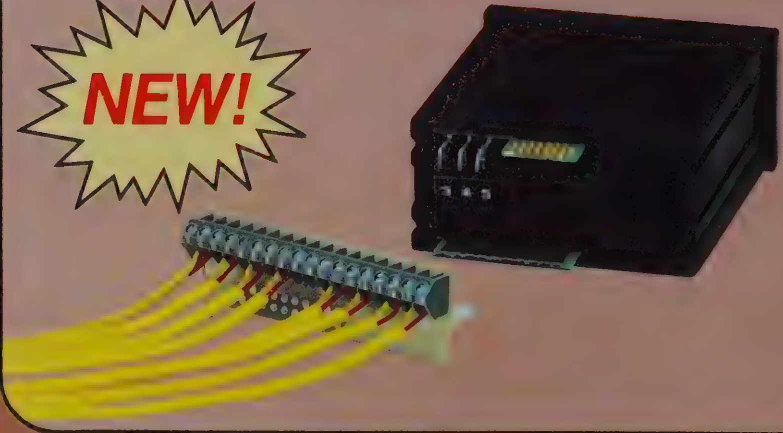
SPECIFY MDP-8

$310

OFF-THE-SHELF!

EXCLUSIVE! VISE TYPE TERMINAL BOARD

NEW!

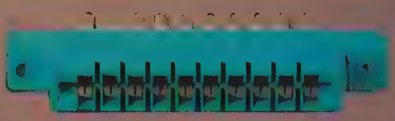


Included as standard

Also Available

SOLDER TAB CONNECTOR

OMX 1803 $7



Precision Calibrators and Bench Thermometers

CL6501
TEMP °C
T1 T2 °C
2999.9
BAT mV
OMEGA
CL6502
T1 T2 °C °F
2999.9
PEAK BAT mV HOLD
PEAK °C/°F HOLD
OMEGA
CL6503
T1 T2 °C °F
2999.9
PEAK BAT CAL mV HOLD
FAST
CAL
PEAK °C/°F HOLD
MEAS
OMEGA

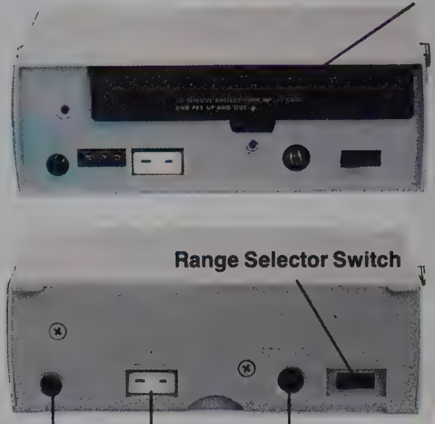
NEW!

Series CL-6500

Prices start at

$460

Precision Calibration and Measurement Instruments


Rechargeable battery pack
Range Selector Switch
Remote Hold jack
Battery Charger jack
Miniature thermocouple jack input fits OMEGA SMP and NMP connectors

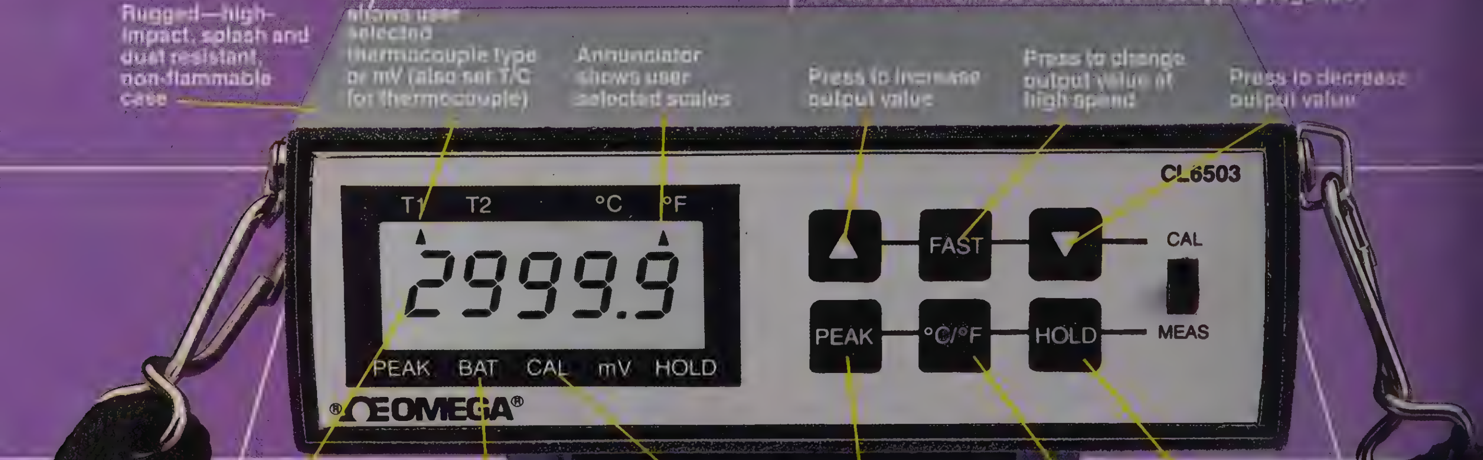
FULLY PORTABLE

FREE Adaptor

FREE
Type K beaded wire thermocouple with convenient SMP connector

FAST CONNECTIONS

The Rear Panel Connector accepts all miniature or subminiature thermocouple plugs. A FREE standard to miniature adaptor is also supplied so your CL-6500 can be used with standard size thermocouple plugs too!


Rugged—high-impact, splash and dust resistant, non-flammable case
Annunciator shows user selected thermocouple type or mV (also set T/C for thermocouple)
Annunciator shows user selected scales
Press to increase output value
Press to change output value at high speed
Press to decrease output value
CL6503
T1
T2
°C
°F
2999.9
PEAK
BAT
CAL
mV
HOLD
FAST
CAL
MEAS
PEAK
°C/°F
HOLD
OMEGA
Easy-to-read 5-digit LCD display
Annunciator shows user selected function
Press to read value in °C or °F
Flashes when battery pack is low
Press to read highest/lowest measured value
Press to freeze displayed measurement
Retractable stand for bench top use

CL-6503 Precision Thermometer/Calibrator

$765

Easy-to-use

The CL-6501 and CL-6502 are portable bench thermometer versions of the precision CL-6500 calibrator. Each model has internally selectable thermocouple types in every instrument, with any two types and mV operating together (via rear panel switch). These units share the same accuracy and broad ranges of the CL-6503 calibrator.

The CL-6502 is a digital thermometer with PEAK, HOLD, and °C/°F selection. The CL-6501 is simply a high accuracy, portable thermometer with a dedicated °C or °F display. Now you can measure temperature and calibrate instrumentation in the field with laboratory precision.

Refer to page K-34 for specification on the Series CL-6500.

CL-6501 Precision Bench Thermometer

- 0.1° Resolution
- 11 Switchable Thermocouple Types
- High Accuracy

CL-6502 Precision 3 Function Bench Thermometer

- Peak/Valley Reading
- Display Hold
- °C/°F Switchable

CL6501
TEMP °C
T1
T2
°C
2999.9
BAT
mV
ΩEOMEGA
CL6502
T1
T2
°C
°F
2999.9
PEAK
BAT
mV
HOLD
PEAK
°C/°F
HOLD
ΩEOMEGA

$460
CL-6501

Series SDX Handle Probes prices start at $35

See Section A

Probes not included with Series CL-6500 instruments.

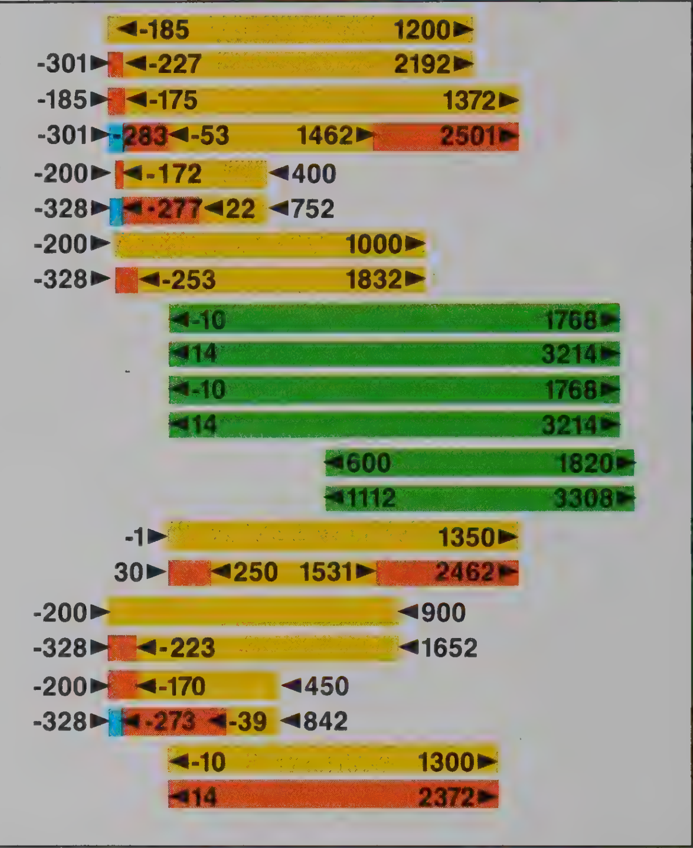
$560
CL-6502

See Section A

Type SCASS miniature probes prices start at $24

Choose from Eleven Thermocouples

Thermocouple Functions



T/C Type		Temperature Range and Resolution[1] Colored bars indicate usable range of T/C. Different colors indicate change in resolution. 0.1° 0.2° 0.5° 1.0°	Conformity[2] ±°C/°F	RSS Accuracy[3] ±°C/°F	Overall Accurac ±°C/°F
J	°C	◄-185 1200►	0.23/0.41	0.29/0.53	0.74/1.34
	°F	-301► ◄-227 2192►			
K	°C	-185► ◄-175 1372►	0.23/0.41	0.35/0.64	1.00/1.80
	°F	-301► -283 ◄-53 1462► 2501►			
T	°C	-200► ◄-172 ◄400	0.23/0.41	0.26/0.46	0.46/0.82
	°F	-328► ◄-277 ◄22 ◄752			
E	°C	-200► 1000►	0.23/0.41	0.28/0.51	0.68/1.23
	°F	-328► ◄-253 1832►			
R	°C	◄-10 1768►	0.38/0.68	0.67/1.20	1.37/2.46
	°F	◄14 3214►			
S	°C	◄-10 1768►	0.36/0.64	0.71/1.28	1.52/2.72
	°F	◄14 3214►			
B	°C	◄600 1820►	0.44/0.79	0.72/1.29	1.32/2.3
	°F	◄1112 3308►			
Platinel II (AuPt/Pd)	°C	-1► 1350►	0.19/0.35	0.41/0.73	1.11/2.00
	°F	30► ◄250 1531► 2462►			
J-DIN	°C	-200► ◄900	0.21/0.38	0.26/0.47	0.57/1.03
	°F	-328► ◄-223 ◄1652			
T-DIN	°C	-200► ◄-170 ◄450	0.21/0.38	0.24/0.44	0.46/0.82
	°F	-328► ◄-273 ◄-39 ◄842			
N (Nicrosil/Nisil)	°C	◄-10 1300►	0.22/0.40	0.33/0.59	0.86/1.5
	°F	◄14 2372►			
Temperature →	°C	-300 0 300 600 900 1200 1500 1800 2100			
	°F	-502 32 572 1112 1652 2192 2732 3272 3812			

Millivolt Functions

Voltage Range	Resolution	RSS Cal. Accuracy[3]	Overall Accuracy[4]
−9.998mV to +99.998mV	0.002mV	±0.012% of Reading + 0.004 mV	±0.035% of Reading + 0.008 mV

Notes

1. For thermocouple calibrated functions, the output range −9.998mV to +99.998mV with resolution and accuracy per the c responding temperatures shown. **2.** Data conformity to ANSI Spe MC 96.1-1975. NBS Monograph 161, DIN-43710, or manufacture of Platinel II. **3.** RSS = the square root of the sum the squares of all the error contributions involved at 25° ±2° **4.** Instrument RSS accuracy at 25°C ±10°C, after 1 year.

Ordering is as easy as 1-2-3

[1] Instruments are shipped configured to *your* specifications! Although 11 thermocouple types are internally selectable—
Specify the two types to be active on rear panel switch. J—K—T—E—N—Platinel II—J Din— T-Din—R—S—B

[2] **Specify** °C or °F. CL-6501 is dedicated either °C or °F. The CL-6502 and CL-6503 are switchable between °C and °F; they will, however, show a specified scale when turned on.

[3] **Specify** line voltage for Battery Charger—110 V ac or 220 V ac.

HOW TO ORDER

Off-the-Shelf Delivery

Code	Description	Pri
CL-6501-[1]-[1]-[2]-[3]	Dedicated °C or °F thermometer including NiCad battery pack, charger, neckstrap, vinyl case, and instruction manual.	$46
CL-6502-[1]-[1]-[2]-[3]	Same as above, except with controls for peak reading, °C/°F changes, hold function.	56
CL-6503-[1]-[1]-[2]-[3]	Calibrator-thermometer. Same as CL-6502 plus a precision calibration source.	76

See page **K-37** for accessori

Series 2160A/2170A High Performance Digital Thermometers

atures and Options

- igh Performance
- ight Thermocouple Types: J, K, E,
, R, S, B, C
- emperature Range, −200°C to
2328°C, or −328°F to 3999°F
- ° and 0.2° Resolution Models
- ultitype, 8 Thermocouple Types
n One Instrument
- attery Operation
- solated, Buffered Digital Output
- inearized, Isolated Analog Output
- pen Thermocouple Indication
- i-Lo Set Point Comparator
- ultipoint to 50 Points
- IN Package Standard
- F or °C Selectable Ranges

1874C
76F
THERMOCOUPLE
OMEGA DIGITAL THERMOMETER
CHANNEL
TEMP
187C
376C
-22F

Series 2160A/2170A High Performance Digital Thermometers by OMEGA ENGINEERING

1243 °C
Ω OMEGA DIGITAL THERMOMETER

Introduction

The OMEGA 2160A and 2170A Series Digital Thermometers complement a broad temperature measurement capability that includes these "high performance" Thermometers which are designed for long term accuracy and dependability.

The Models 2160A/2170A offer users a choice of seven basic instruments plus a full complement of application oriented options and accessories. The thermometers provide resolution of 1° for the 2160A Series and 0.2° for the 2170A Series from thermocouple inputs. The various models will measure temperatures from −200°C to 2328°C, or −328°F to 3999°F over the useful range of eight thermocouple types. The versatility of the 2160A/2170A product line results from careful consideration and understanding of the wide spectrum of user needs whether in basic research, engineering test, or on-line industrial applications. There is a choice of single-point, multi-point, or multi-type thermocouple input. The instruments are available in either panel mounting configuration or portable bench models. The 2165A and 2175A bench units will operate on either line or battery power. System application flexibility is enhanced by options that include a panel mount multi-point selector switch unit, a digital single limit comparator, a linearized analog output unit and a digital output unit.

The separate packaging configurations reflect thorough application and engineering design to match the unique demands of the job to be done in either the lab or the plant. Bench models are housed in a rugged case. There is an integral rechargeable battery option in the two single-point models for true portability. All bench models feature the convenience of front panel push-button selection of power (ON/OFF) and temperature scale (°F or °C).

The panel mounting instruments are housed in a rugged, unibody metal case and are designed for use in harsh industrial environments. The extremely compact package conforms to DIN standards and is designed for convenient installation in console control panels. Mounting cams are an integral part of the case. The instrument has been designed for maximum ease of access for calibration and thermocouple connection. Temperature scale selection by the user is accomplished simply by means of a jumper accessible behind the front lens.

Measurement Technique

The use of a single custom LSI chip for the digital portion of the thermometer A to D converter and ROM storage of all the thermocouple linearization programs in the 2160A/2170A design results in using fewer components than other digital thermometers, with an inherent increase in reliability. Dual slope integration, coupled with RF and line transient filtering provides excellent noise rejection and immunity to interference typically found in industrial applications. Superior conformity to NBS thermocouple curves is achieved with 48 straight line segments which have been computer optimized for best possible fit for each thermocouple type.

Rear panel, screw type input terminals are provided on all of the instruments for attaching the selected input thermocouple. These terminals are part of an isothermal block and serve as the reference junction for the reference junction compensator. The temperature of the block is detected by a transistor whose base emitter current has been calibrated with temperature. The reference junction compensator output voltage is then proportional to ambient temperature and is used to compensate thermocouple output to 0°C or 32°F.

The 2160A/2170A series instrument features a large, bright, easy to read display for unambiguous readout of 4 digits with leading zero suppression, minus sign, and °C or °F temperature scale. All instruments are equipped with circuitry to detect burned out or defective thermocouples as well as input overload. The display will blink when input voltage exceeds full scale temperature range or if the thermocouple circuit is open.

Digital Thermometer Accuracy

OMEGA has long been the recognized standard of performance in Temperature Measurement. This expertise in temperature measurement has been effectively extended to meet the exacting demands of digital thermometry. OMEGA's reputation and preeminence in temperature instrumentation has been built not only on innovative use of new technology, but upon quality of product and integrity of specifications. All OMEGA instrument specifications are expressed as a total accuracy statement, with all error terms included. These high performance instruments are guaranteed to operate within the limits of the worse case conditions of the published specifications which is the user's ultimate assurance of predictable performance in application.

Any digital thermometer using contemporary analog-to-digital conversion techniques can be characterized by a statement of total instrument measurement accuracy that must account for all the following error terms:

NBS Curve Conformity: Absolute worst case deviation over complete thermocouple span.

Calibration: ±1/2 digit (resolution) + NBS conformity at calibration point.

Span: Expressed as percent of reading, °F/°C. Function of reference voltage temperature coefficient.

Zero: Ambient temperature error from components outside auto-zero loop (negligible in OMEGA A/D converter).

Reference Junction: Expressed in degrees per degree deviation from 25°C/77°F. Consists of linearity error plus temperature coefficient error.

Noise: Inherent instrument noise expressed in microvolts.

Stability: Expressed in percent of reading (reference voltage change) + absolute error in degrees (reference junction compensation change).

The interrelationship of accuracy, resolution and stability determine the suitability of the digital thermometer in temperature measurement applications. Because the error terms associated with full span, full operating ambient temperature range, and effects of drift with time from initial calibration accuracy are worst case statements, it may be desirable to know the total instrument related error for a given set of measurement conditions. OMEGA can supply accuracy data for specific applications upon request.

ODEL 2165A: 1° Resolution

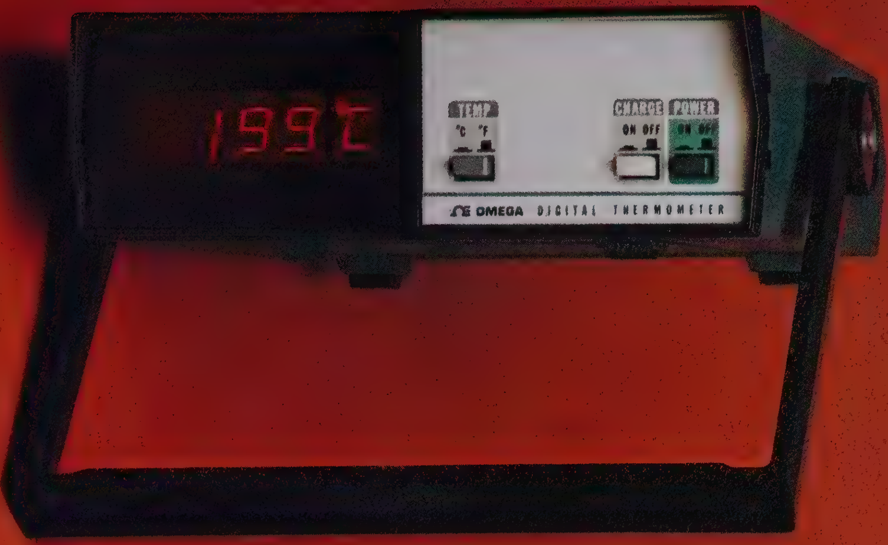
igital Thermometer for single ype of thermocouple

he 2165A is a portable, single-point nstrument in a rugged bench mount ase with specifications identical to the 160A. It can be equipped with a echargeable battery pack. Push utton controls include power ON/OFF), temperature scale election, (°F/°C), and battery charge.

hen ordering specify thermocouple type: K, T, E, R, S, B, or C, as suffix to model umber.

ee Model 2160A for Specifications and anges.

$575



199°C
TEMP
°C °F
CHARGE
ON OFF
POWER
ON OFF
Ω OMEGA DIGITAL THERMOMETER

ODEL 2166A: 1° Resolution

igital Thermometer for ten hermocouples of the same type

he 2166A is the same basic bench-pe instrument as the 2165A but with dditional capability for monitoring up ten thermocouples of the same type. hermocouple channel selection is by 10-position front panel rotary switch. ower is either line voltage or external 2 volts DC.

hen ordering specify thermocouple type: K, T, E, R, S, B, or C, as suffix to model umber.

ee Model 2160A for Specifications and anges.

$680

76°F
CHANNEL
TEMP
°C °F
POWER
ON OFF
Ω OMEGA DIGITAL THERMOMETER

ODEL 2168A: 1° Resolution

igital Thermometer for eight pes of thermocouples

ne 2168A is a portable, single-point strument capable of accepting input om any one of eight thermocouple pes. Performance specifications are entical to the 2160A for each ermocouple type. Front panel ontrols include push-button power witch (OFF/ON) and temperature cale selection (°F/°C), plus an eight-osition rotary switch for selection of ermocouple type. Power is either line oltage or external 12 volts DC.

ight Thermocouple Types

J - Iron vs Constantan
K - Chromel vs Alumel
T - Copper vs Constantan
E - Chromel vs Constantan
R - Platinum vs Platinum 13% Rhodium
S - Platinum vs Platinum 10% Rhodium
B - Platinum 6% Rhodium vs Platinum 30% Rhodium
C - Tungsten 5% Rhenium vs Tungsten 26% Rhenium

ee Model 2160A for Specifications and anges.

$810

187°C
THERMOCOUPLE
TEMP
°C °F
J K T E R S B C
POWER
ON OFF
Ω OMEGA DIGITAL THERMOMETER

All Thermocouple Types

$440

376°C
OMEGA DIGITAL THERMOMETER

Specifications

MODEL 2160A:

Digital Thermometer for single type of thermocouple

The 2160A is a panel-mounted, four-digit, thermocouple thermometer capable of resolving 1°C or 1°F over the entire temperature span of any of eight thermocouple types. (J, K, E, T, R, S, B, C)

ELECTRICAL

Compatible Thermocouple Types	J, K, T, E, R, S, B or C
Measurement Method	Dual-slope integration over a 100 ms period.
Zero Drift	None. Automatic zero correction.
Reading Rate	2.5 readings per second
°C to °F Conversion	Jumper selectable
Input Characteristics	
Input Connections	Screw terminals on isothermal connector
Input Circuit	Two-wire, isolated
Input Impedance	100 MΩ
Input Current	500 pA
Source Impedance	5kΩ (5kΩ causes <0.2°C error with K thermocouple)
Overload	Display flashes when input voltage exceeds full-scale temperature range
Open Input	Display flashes to indicate open at input terminals.
Maximum Input Voltage (without damage)	400V dc or ac peak continuously between inputs or either input and ground.
Maximum Common Mode Voltage (without damage)	400V dc or ac peak.
Common Mode Rejection	120 dB @ 50, 60, 400 Hz ±0.1% with 1k Ω source impedance unbalance.
Normal Mode Rejection	60 dB @ 50, 60, 400 Hz ±0.1%

Accuracy	See Table 1 for °C specifications and Table 2 for °F specifications.
Response Time to Rated Accuracy	<2.0 seconds.
Linearization	Digital with eight selectable programs in LSI ROM.
Linearization Programs	
J, K, T and E	32 straight line segments for positive inputs and 16 for negative inputs.
R, S, B and C	48 straight line segments for positive inputs.
Reference Junction Compensation 20 to 30°C	
J, K, T, E	0.025 degrees per degree
R, S	0.05 degrees per degree
C	0.02 degrees per degree
0 to 20°C, 30 to 50°C	
J, K	0.032 degrees per degree
T, E	0.045 degrees per degree
R, S	0.07 degrees per degree
C	0.04 degrees per degree
Temperature Coefficient	0.005% of reading per °C
Internal Temperature Rise	5°C

ACCURACY SPECIFICATIONS °C TABLE 1

(Maximum error includes NBS conformity, calibration, span, zero, reference junction, noise, and stability, but does not include thermocouple errors.) Resolution and Repeatibility ±1°C.

CATALOG DESIGNATION	TEMPERATURE RANGE °C	APPLICABLE TEMPERATURE RANGE °C	MAXIMUM INSTRUMENT ERROR* (±°C)			NBS CONFORMITY (±°C)
			CALIBRATION ACCURACY	90 Days 20° to 30° C	1 Year 15° to 35° C	
2160A-J	−200 to 778	−200 to 0 0 to 778	1 1	1.5 1	1.5 1.5	.19 .15
2160A-K	−200 to 1356	−200 to 0 0 to 1356	1 1	1.5 1.5	2 2	.20 .18
2160A-T	−200 to 400	−200 to 0 0 to 400	1 1	1.5 1	2 1	.19 .15
2160A-E	−200 to 1000	−200 to 0 0 to 1000	1 1	1.5 1	2 1.5	.17 .18
2160A-R	0 to 1778	0 to 1778	1.5	2.5	3	.26
2160A-S	0 to 1778	0 to 1778	1.5	2	3	.22
2160A-B	533 to 1844	533 to 1844	1.5	2	2.5	.29
2160A-C	0 to 2328	0 to 2328	2.5	3.5	4	.71

*Add 0.2°F for Model 2166A.

ACCURACY SPECIFICATIONS °F TABLE 2

(Maximum error includes NBS conformity, calibration, span, zero, reference junction, noise, and stability, but does not include thermocouple errors.) Resolution and Repeatibility ±1°F.

CATALOG DESIGNATION	TEMPERATURE RANGE °F	APPLICABLE TEMPERATURE RANGE °F	MAXIMUM INSTRUMENT ERROR* (±°F)			NBS CONFORMITY (±°F)
			CALIBRATION ACCURACY	90 Days 68° to 86° F	1 Year 59° to 95° F	
2160A-J	−328 to 1432	−328 to 32 32 to 1432	1.5 1	2 1.5	2.5 2	.27 .2
2160A-K	−328 to 2472	−328 to 32 32 to 2472	2 1.5	2.5 2.5	3 3	.28 .26
2160A-T	−328 to 752	−328 to 32 32 to 752	1.5 1	2 1.5	3.5 2	.3 .2
2160A-E	−328 to 1832	−328 to 32 32 to 1832	1.5 1	2 2	3.5 2.5	.25 .25
2160A-R	32 to 3232	32 to 3232	2	4	5	.4
2160A-S	32 to 3232	32 to 3232	2	3.5	4.5	.33
2160A-B	992 to 3352	992 to 3352	2	3.5	4.5	.45
2160A-C	32 to 3999	32 to 3999	4	6	6.5	1.24

*Add 0.1°C for Model 2166A

NOTE: When ordering specify thermocouple type, J, K, T, E, R, S, B, or C, and specify degrees C or degrees F readout.

MODEL 2170A:

Digital Thermometer for single type of thermocouple

The 2170A is a panel-mounted, four-digit thermocouple thermometer, capable of .2 (°F or °C) resolution over a temperature range of −99.8 to +999.8°C, or −99.8 to +999.8°F, for four thermocouple types. (J, K, E, T)

When ordering specify thermocouple type: J, K, E or T as suffix to model number.

37.6°C
ΩE OMEGA DIGITAL THERMOMETER

$480

ELECTRICAL

Compatible Thermocouple Types	J, K, T, E
Measurement Method	Dual-slope integration over a 100 ms period.
Zero Drift	None. Automatic zero correction
Reading Rate	2.5 readings per second.
°C to °F Conversion	Jumper selectable
Input Characteristics	
Input Connections	Screw terminals on isothermal connector
Input Circuit	Two-wire, isolated
Input Impedance	100 MΩ
Input Current	500 pA
Source Impedance	5kΩ (5kΩ causes < 0.2 C error with K thermocouple)
Overload	Display flashes when input voltage exceeds full-scale temperature range.
Open Input	Display flashes to indicate open at input terminals
Maximum Input Voltage (without damage)	400 VDC or AC peak continuously between inputs or either input and ground.
Maximum Common Mode Voltage (without damage)	400 VDC or AC peak.
Common Mode Rejection	120 dB @ 50, 60, 400 Hz ±0.1% with 1kΩ source impedance unbalance.
Normal Mode Rejection	60 dB @ 50, 60, 400 Hz ±0.1%

Accuracy	See Table 3 for °C specifications and Table 4 for °F specifications.
Response Time to Rated Accuracy	< 2.0 seconds
Linearization	Digital with four selectable programs in LSI ROM.
Linearization Programs	
J, K, T and E	32 straight line segments for positive inputs and 16 for negative inputs
Reference Junction Compensation	
20 to 30°C	
J, K, T, E	0.025 degrees per degree
0 to 20°C, 30 to 50°C	
J, K	0.032 degrees per degree
T, E	0.045 degrees per degree
Temperature Coefficient	0.005% of reading per °C
Internal Temperature Rise	5°C

ACCURACY SPECIFICATIONS °C TABLE 3

(Maximum error includes NBS conformity, calibration, span, zero, reference junction, noise, and stability, but does not include thermocouple errors.) Resolution and Repeatability ±0.2°C.

CATALOG DESIGNATION	TEMPERATURE RANGE °C	APPLICABLE TEMPERATURE	MAXIMUM INSTRUMENT ERROR* (±°C)			NBS CONFORMITY (±°C)
			CALIBRATION ACCURACY	90 Days 20 to 30°C	1 Year 15 to 35°	
2170A-J	−99.8 to 777.8	−99.8 to 0 0 to 777.8	0.5 0.4	1 0.7	1.2 1.1	.19 .15
2170A-K	−99.8 to 999.8	−99.8 to 0 0 to 999.8	0.7 0.5	1.2 1.1	1.5 1.4	.2 .18
2170A-T	−99.8 to 400	−99.8 to 0 0 to 400	0.6 0.4	1 0.6	1.6 0.9	.19 .15
2170A-E	−99.8 to 999.8	−99.8 to 0 0 to 999.8	0.6 0.5	1 1	1.7 1.4	.17 .18

*Add 0.1°C for Model 2176A.

ACCURACY SPECIFICATIONS °F TABLE 4

(Maximum error includes NBS conformity, calibration, span, zero, reference junction, noise, and stability, but does not include thermocouple errors.) Resolution and Repeatability ±0.2°F.

TEMPERATURE RANGE	APPLICABLE TEMPERATURE RANGE °F	MAXIMUM INSTRUMENT ERROR* (±°F)			NBS CONFORMITY (±°F)
		CALIBRATION ACCURACY	90 Days 68 to 86°F	1 Year 59 to 95°F	
−99.8 to 999.8	−99.8 to 32 32 to 999.8	0.9 0.7	1.6 1.2	2.1 1.6	.27 .2
−99.8 to 999.8	−99.8 to 32 32 to 999.8	1.1 1	2.0 1.4	2.6 1.8	.28 .26
−99.8 to 752	−99.8 to 32 32 to 752	0.9 0.6	1.7 1	2.9 1.5	.3 .2
−99.8 to 999.8	−99.8 to 32 32 to 999.8	0.9 0.8	1.7 1.3	3.0 1.8	.25 .25

*Add 0.2°F for Model 2176A

OTE: When ordering specify thermocouple type J, K, T, or E as suffix to model number and specify degrees C or degrees F.

1874°C
TEMP
°C °F
CHARGE
POWER
ON OFF
ON OFF
OMEGA DIGITAL THERMOMETER

MODEL 2175A: 0.2° Resol

Digital thermometer for single t
of thermocouple

The 2175A is a portable, single-poi
instrument in a rugged bench moun
case with the same specifications a
the 2170A. It can be equipped with
rechargeable battery pack. Push-
button controls include a power swi
(ON/OFF), temperature scale selec
(°F/°C), and battery charge.

When ordering specify thermocouple ty
J, K, E, or T as suffix to model number.

See Model 2170A for Specifications an
Ranges.

$67

73.2°F
CHANNEL
TEMP
°C °F
1
2
3
4
5
6
7
8
9
10
POWER
ON OFF
OMEGA DIGITAL THERMOMETER

MODEL 2176A: 0.2° Resolu

Digital thermometer for ten
thermocouples of the same type

The 2176A is the same basic bench
type instrument as the 2175A but wi
additional capability for monitoring
to ten thermocouples of the same ty
Thermocouple channel selection is
means of a 10-position front panel
rotary switch. Power is either line
voltage or external 12-volts DC.

When ordering specify thermocouple ty
J, K, E, or T as suffix to model number.

See Model 2170A for Specifications an
Ranges.

$80

Options

MODEL 2161A: $200

Multipoint selector switch for ten thermocouples

The Model 2161A Multipoint Selector is a panel-mounting, manually-switched selector that allows 1-of-10 thermocouple probes (all of the same type) to function as the thermocouple input to the 2160A or 2170A. Two or more 2161A's can be connected in either a serial or parallel configuration for monitoring up to 50 thermocouple inputs.

MODEL 2162A: $370

Digital Comparator for limits indication and control

The Model 2162A Digital Comparator is a panel-mounting, manually set, single-limit comparator compatible with 2160A or 2170A. Front panel, thumb-wheel switches provide for the selection of high or low, polarity and four limit digits. The resolution of the 2162A is ±1°. When an out of limit reading occurs, the 2162A generates a visual indication and a contact closure occurs. The contact is accessible through the 2162A rear panel, and is electrically isolated from the thermometer. Two 2162A's can be connected in parallel for dual limit requirements.

OPTION –01 $95

Rechargeable battery for portable operation

The rechargeable Battery Option can be used in Models 2165A and 2175A only, and provides continuous operating time of 8 hours. The batteries are recharged from line power in either trickle or full charge mode within the instrument.

Type of Cell: Rechargeable Ni-Cad, "D"
Configuration: Self-contained within the instrument
Number: Four cells providing 4.8 volts
Operating Time: Typically 8 hours continuous
operation at 25°C

OMEGA 2161A MULTIPOINT SELECTOR

MODEL 21

+ 0 1 9 8
LIMIT
OMEGA 2162A DIGITAL COMPARATOR

MODEL 21

General Specifications

Type of Display	LED, 0.56 in high.
Power Requirements	
Line Operation	115V AC + 10%, 50 to 440 Hz, 8W. 100V AC and 230V AC versions are also available.
Battery Operation (2165A, 2175A only)	4.8V DC @ 350 mA (Four internal, D-size, Ni-Cad batteries −01 option). Eight hours of operation on a full charge.
External DC Source (2166A, 2168A, 2176A only)	11 to 15V DC @ 400mA
Size	
Models 2160A & 2170A	1.88 in (H) x 3.78 in (W) x 8.05 in (D) (4.78 cm x 9.6 cm x 20.45 cm). Conforms to DIN standard.
Models 2165A, 2166A, 2168A, 2175A & 2176A	2.52 in (H) x 8.55 in (W) x 9.9 in (D) (6.40 cm x 21.72 cm x 25.15 cm).
Weight	
Models 2160A & 2170A	1 lb. 10 oz. (0.737 kg)
Models 2165A & 2175A	
Without Batteries	2 lbs. 10 oz. (1.19 kg)
With Batteries	3 lbs. 15 oz. (1.79 kg)
Models 2166A, 2168A & 2176A	3 pounds (1.35 kg)

Environmental Specifications

Operating Temperature	0 to 50°C (32 to +122°F)
Storage Temperature	
With Batteries	−40 to 60°C (−40 to 140°F)
Without Batteries	−40 to 75°C (−40 to 167°F)
Humidity	
0 to 50°C	80% non-condensing
0 to 35°C	90% non-condensing
Shock and vibration	Meets requirements of MIL Standard 810

Digital Thermometers

Catalog Number	Description	Price
2160A	1°, Single-Point, Panel	$420
2165A	1°, Single-Point, Bench	520
2166A	1°, Multi-Point, Bench	625
2168A	1°, Multi-Type, Bench	735
2170A	0.2°, Single-Point, Panel	455
2175A	0.2°, Single-Point, Bench	610
2176A	0.2°, Multi-Point, Bench	725

Options

Catalog Number	Description	Price
2161A	Multi-Point Selector, Panel	$180
2162A	Digital Comparator, Panel	335
−01	Battery Option	85
−02	Digital Output Option	160
−03	Battery Pack 2166A, 2176A, 2168A	175
−04	Analog Output Option	215

Common Accessories

Catalog Number	Description	Price
MOO-200-611	Rack Mounting Kit, Offset	$ 55
MOO-200-612	Rack Mounting Kit, Center	55
MOO-200-613	Rack Mounting Kit, Side-by-Side	70
MOO-100-714	Front panel dust cover	20
−7010	Extra Multi-Point Input Module	140
−7012	Conversion Kit, R Type	40
−7013	Conversion Kit, S Type	40
−7014	Conversion Kit, B Type	40
−7015	Conversion Kit, C Type	40
−7016	Conversion Kit, J Type	40
−7017	Conversion Kit, K Type	40
−7018	Conversion Kit, T Type	40
−7019	Conversion Kit, E Type	40
−7022	Cable & Connector for −02 & −04 options	35
−7031	Rack Mount Panel, Single	90
−7032	Rack Mount Panel, Double	90
−7033	Rack Mount Panel, Triple	90

Thermocouple Choices

J - Iron vs Constantan
K - Chromel vs Alumel
E - Chromel vs Constantan
T - Copper vs Constantan
R - Platinum vs Platinum 13% Rhodium
S - Platinum vs Platinum 10% Rhodium
B - Platinum 6% Rhodium vs Platinum 30% Rhodium
*C - Tungsten 5% Rhenium vs Tungsten 26% Rhenium

*Not an ANSI symbol.

Option −02 $180

Digital output unit

The Digital Output Option is field installable and mounts on the interior of any of the instruments. It provides a digital output which is equivalent to the displayed measurement data. The digital output is positive-true, TTL compatible and is presented in BCD, character-parallel format. All displayed characters are represented at the output. Output data is solicited by an External Trigger input and valid data is ensured by Busy and Not Busy outputs. A 6-foot ribbon cable and connector is available as an accessory. One is included with the 02 option.

Type of Output: Fully isolated, buffered, parallel BCD, TTL/DTL compatible
Available Data: Digits, Polarity, Function (°C or °F)
Data Coding: 8-4-2-1 BCD positive true parallel
Logic Levels: "1" >4.5V, "0" < 0.5V
Flags: Busy, Not Busy
Controls: External Trigger, External Trigger Enable
Isolation: Fully isolated to 300V DC or AC peak

Option −03 $195

Battery pack for 2166A, 2176A, 2168A

Rechargeable Ni-Cad batteries and soft vinyl case, is designed for the Models 2166A, 2176A, and the 2168A, and provides portable battery operation for these models.

Option −04 $235

Analog output unit

The Analog Output Option is a field installable assembly which provides an analog output voltage proportional to the displayed measurement data. The output voltage is electrically isolated from the instrument. Automatic polarity sensing is provided for both °C and °F measurements to ensure that the polarity of the output voltage agrees with the displayed polarity. Since the analog output terminals are isolated, the output voltage is referenced to the low terminal of the external recording device (voltmeter, strip-chart recorder, etc.) A 6-foot ribbon cable and connector is available as an accessory. The −02 and −04 options are mutually exclusive. One is included with the 04 option. The Analog Output Unit is not operational when the 2166A is powered by an external 12Vdc source.

Output Current: 10mA
Linearity: ±0.5% of full scale
Isolation: Fully isolated to 300V DC or AC peak

NOTE:
FOR OTHER MULTIPOINT SELECTOR SWITCHES, TWO (2) TO FORTY (40) PLACES, SEE PAGES G-27 & 28.

-02 & -04 Options will only operate when the meter is operated on line voltage. When the meter is operating from internal batteries or external 12 volt DC, the 02 & 04 options are inoperative.
All models in 2160A and 2170A series digitals sold with either an 02 or an 04 option will be shipped with the option installed. Installation charge is $11.

199°C
TEMP
°C °F
CHARGE
ON OFF
POWER
OMEGA
2165A DIGITAL THERMOMETER

SELECTION GUIDE

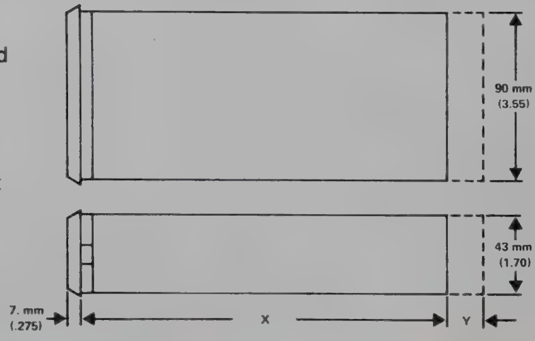
DESCRIPTION	MODEL/OPTION NUMBER	2160A	2170A	2165A	2175A	2166A	2176A	2168A
OPTIONS:								
RECHARGEABLE BATTERIES	–01			●	●			
DIGITAL OUTPUT	–02	●	●	●	●	●	●	●
RECHARGABLE BATTERY PACK WITH SOFT CASE	–03					●	●	●
ANALOG OUTPUT	–04	●	●	●	●	●	●	●
OUTPUT CABLE FOR –02, –04	–7022	●	●	●	●	●	●	●
MULTIPOINT SELECTOR	2161A	●	●					
DIGITAL COMPARATOR	2162A	●	●					
ACCESSORIES:								
PROBE, J TYPE	TJ-36-J-1/8-G	●	●	●	●	●	●	●
PROBE, K TYPE	TJ-36-K-1/8-G	●	●	●	●	●	●	●
PROBE, T TYPE	TJ-36-T-1/8-G	●	●	●	●	●	●	●
RACK PANEL FOR 1 UNIT	–7031	●	●					
RACK PANEL FOR 2 UNITS	–7032	●	●					
RACK PANEL FOR 3 UNITS	–7033	●	●					
RACK PANEL, 1 UNIT OFFSET	M00-200-611			●	●	●	●	●
RACK PANEL, 1 UNIT CENTER	M00-200-612			●	●	●	●	●
RACK PANEL, 2 UNITS	M00-200-613			●	●	●	●	●
PANEL DUST COVER	M00-100-714			●	●	●	●	●
CARRYING CASE, SOFT VINYL	C80			●	●	●	●	●
CARRYING CASE, RUGGED	C86			●	●	●	●	●

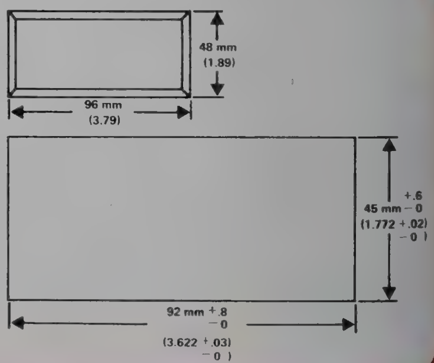
Panel Mounting Dimensions

The **2160A, 2161A, 2162A,** and **2170A** conform to DIN 43700 standards for panel mounting instruments. To facilitate panel preparation and mounting, the drawings below detail the pertinent case and panel cut-out dimensions.

	X	Y
2160/2170	196 mm (7.70)	20 mm (.79)
2161/2162	183 mm (7.21)	15 mm (.60)

Y dimension is allowance for power cord and/or connector for each model.


90 mm
(3.55)
43 mm
(1.70)
7. mm
(.275)
X
Y

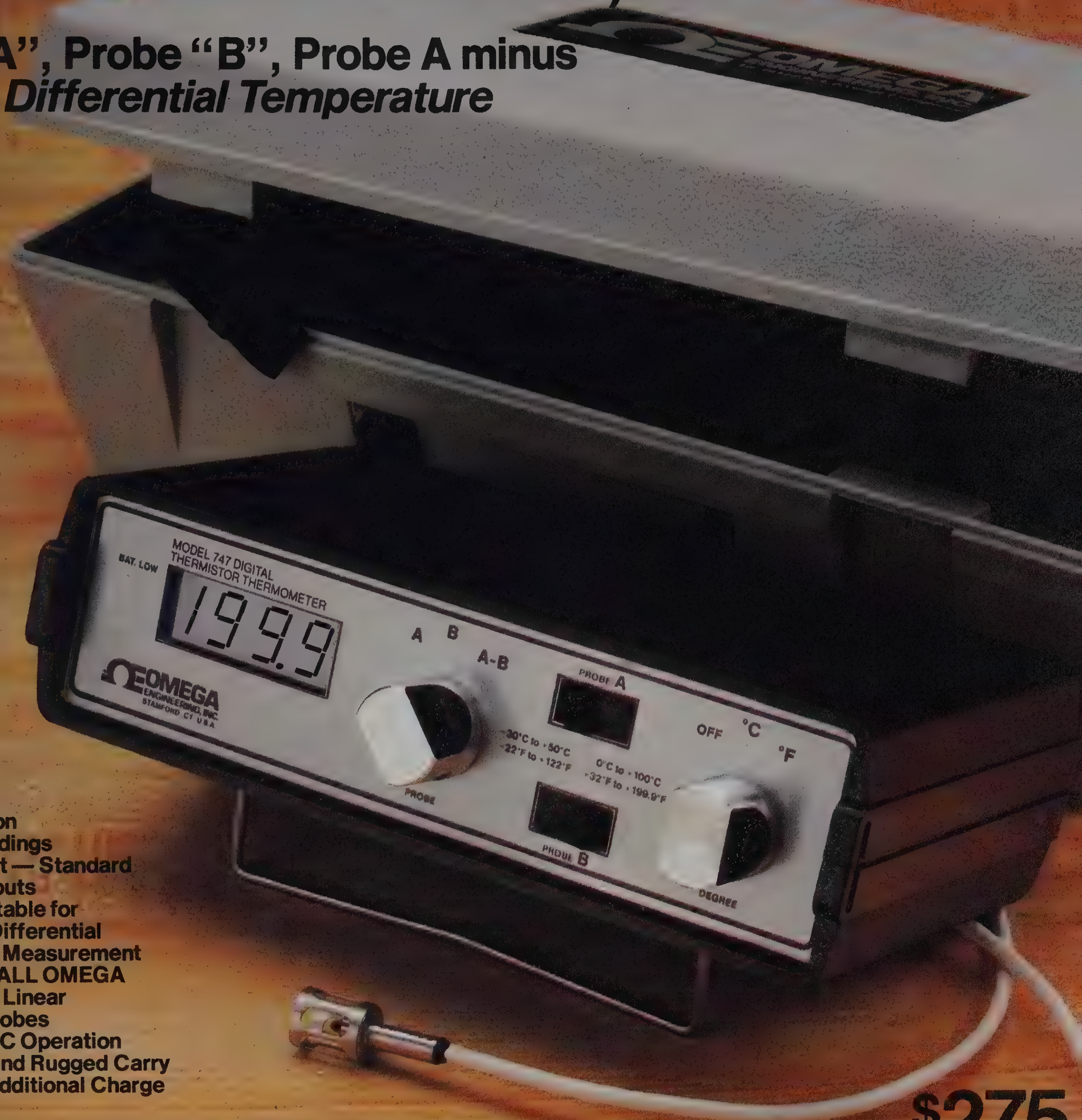

48 mm
(1.89)
96 mm
(3.79)
45 mm +.6 −0
(1.772 +.02 −0)
92 mm +.8 −0
(3.622 +.03 −0)

DIN PANEL CUT-OUT DIMENSIONS

Dimensions shown with mm are in millimeters. Dimensions in parentheses are in inches.

Model 747 Versatile, Two Probe Thermistor Thermometer with Three Measurement Modes)

robe "A", Probe "B", Probe A minus robe B *Differential Temperature*


BAT. LOW
MODEL 747 DIGITAL THERMISTOR THERMOMETER
199.9
OMEGA ENGINEERING, INC. STAMFORD CT USA
A
B
A-B
-30°C to +50°C -22°F to +122°F
0°C to +100°C +32°F to +199.9°F
PROBE
PROBE A
PROBE B
OFF
°C
°F
DEGREE

eatures:

- 0.1° Resolution
- °C and °F Readings
- Analog Output — Standard
- Two Probe Inputs Switch Selectable for Individual or Differential Temperature Measurement
- For USE with ALL OMEGA "700" Series Linear Thermistor Probes
- Battery and AC Operation
- AC Adapter and Rugged Carry Case — No Additional Charge

Model 747-1 **$275**

he Model 747 portable, two input thermistor thermometer rovides °C and °F readings and offers maximum versatility hrough its three-mode temperature measurement peration. By switch selection, you can measure Probe A, robe B, or the Temperature Differential (Probe A minus robe B). Four ranges cover temperatures from -30°C o +100°C and -22°F to +199.9°F with 0.1° resolution. tandard on each instrument is a linearized analog output or driving devices such as a strip chart recorder. The Model 47 can be used with ALL OMEGA "700" Series thermistor robes.

Each Model 747 has an easy-to-read LCD display and is powered by six "AA" batteries which yield 200 hours of continuous service. An AC adapter is included which plugs into a standard 110VAC, 60Hz wall receptacle.

A high impact plastic carrying case is also included for convenience in transporting the Model 747.

All Model 747's are built using quality components and exacting workmanship. A detailed owners manual is included with each instrument.

Complete instrument and accessory specifications are shown on the following page.

MODEL 747 DIGITAL THERMISTOR THERMOMETER
BAT LOW
199.9
OMEGA
A
B
A-B
PROBE
PROBE A
PROBE B
OFF
°C
°F
DEGREE

Model 747 Reads in both °C and °F

Standard Accessories

included in purchase price

AC Adaptor

Model 747 Precision Digital Thermometer has a receptacle on the rear of the case which will accept this accessory. The AC adaptor allows the instrument to be powered from an alternating current source. When instrument Model *747-1* is ordered, the AC adaptor is for standard 110 VAC, 60 Hz service. When Model *747-2* is specified, the AC adaptor is for European 220 VAC, 50 Hz operation; this adaptor is fitted with a DIN standard European plug.

Rugged Carrying Case

The Model 747 carrying case is made from a high-impact plastic fitted with a resilient foam insert with recessed areas for the instrument, an AC adaptor, as well as storage space for temperature probes.

Replacement Batteries (Catalog No. MN 1500-6)

Set of 6 "AA" Alkaline batteries: Price: $3

When Ordering Specify:

Model 747-1
Price: $275

Includes set of 6 "AA" batteries, AC adaptor for 110 VAC, 60 Hz and rugged carrying case. For above items, except 220 VAC, 50 Hz AC adaptor with European plug, specify "Model 747-2"— same price.

General Specifications

Sensors:	Two 700 Series Thermistors	
Ranges:	−30.0 to +50.0°C	−22.0 to +122.0°F
	0.0 to 100.0°C	+32.0 to +199.9°F
Resolution:	0.1°C	0.1°F
Accuracy*:		
Temperature:	0.5°C	0.85°F
Differential Temperature:	1.0°C	1.7°F
Display:	0.5" LCD	
Battery Power:	6 Type "AA" Batteries	
AC Power Adaptors:	110 VAC, 60 Hz *or* 220 VAC, 50 Hz	

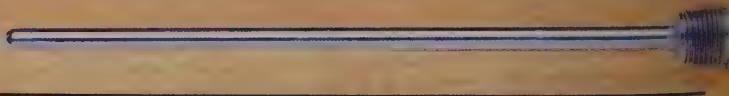
*Includes 700 thermistor sensors and instrument within operating ambient temperature spec and R.H. <85%

	Range Selected	Output
Analog Output:	−30.0 to +50.0°C	11.40 mV/°C
(into a 1000 ohm,	0.0 to 100.0°C	9.00 mV/°C
or greater, device.	−22.0 to 122.0°F	6.30 mV/°F
Accuracy ± 1%.)	+32.0 to 199.9°F	5.00 mV/°F
Operation Ambient Temperature:	+5 to +35°C	+41 to +95°F
Storage Ambient Temperature:	−15 to +55°C	+5 to 131°F
Ambient Humidity:	85% R.H.	
Dimensions:		
Instrument:	7.9" width X 4.7" length X 2.5" high	
Carrying Case:	12.4" width X 8.3" length X 4.0" high	

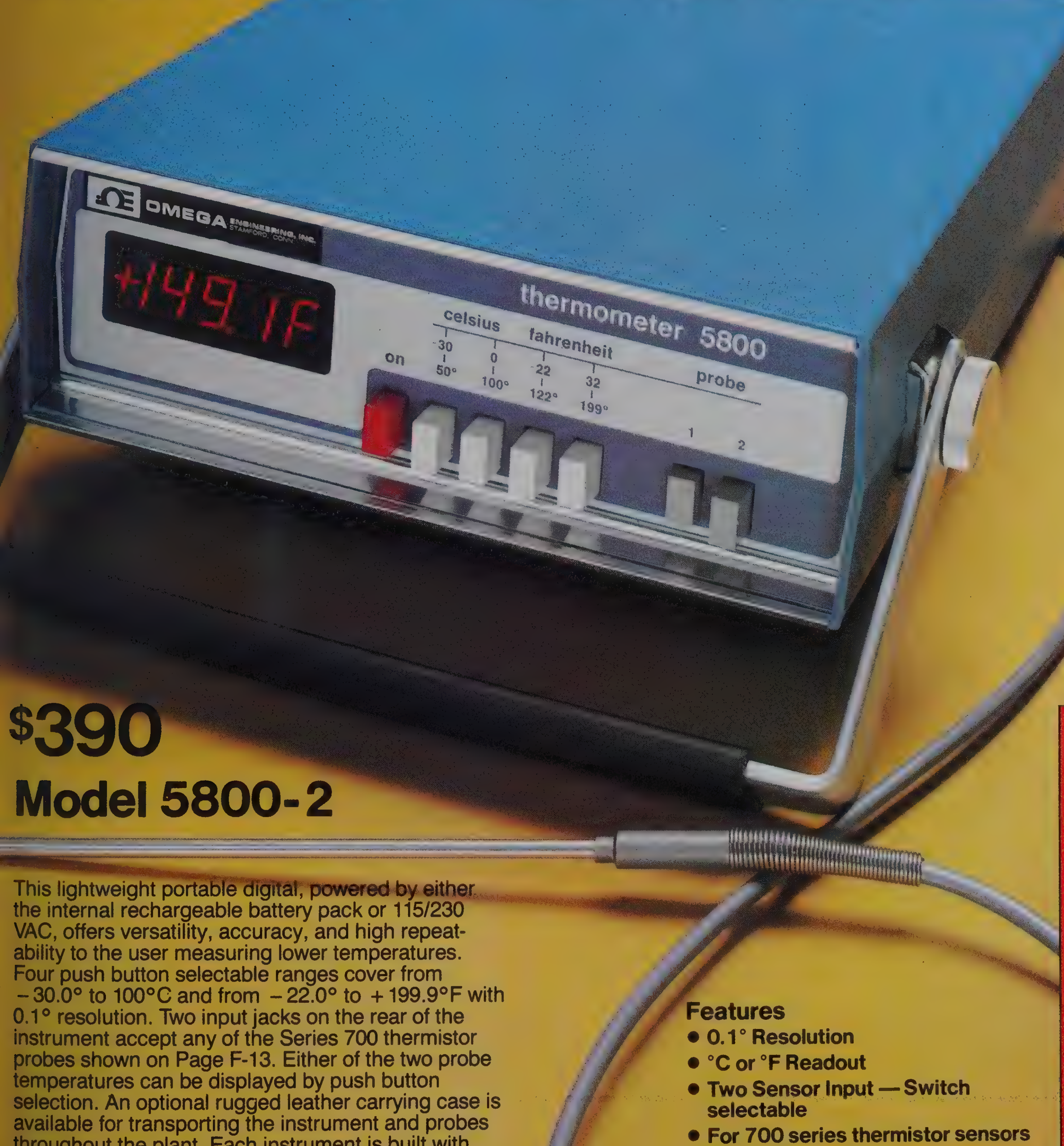
Series "700" Linear Thermistor Probes

OMEGA Series "700" Linear Response Probe Assemblies are designed for use with OMEGA's 5800-2 (pages M-56 and M-57) and 400-THC and THF (page M-27) Series Digitals as well as Models 700 and 747 Thermometers on pages M-54 and M-55. Each probe is fitted with a 44018 sensor and comes with 10 feet of 100°C rated vinyl covered lead wire and phone jack termination. Additional lead lengths are available at $.80 per foot.

The junction between the probe and lead wire is moisture resistant with the exception of Type 709. A three (3) conductor phone plug is supplied as standard termination. Stripped ends can be supplied by adding the suffix -ST. For longer leads, place an "x" after part number and specify length up to 250′.

Catalog Number	Description	Price	Configuration
OL-701-PP	**General Purpose.** Vinyl tipped, most rugged probe. Used with long leads for deep water temperatures. Often buried for sub-soil readings.	**$54**	
OL-709-PP	**Attachable Surface Temperature.** Stainless steel cup, epoxy backed. Easy to tape on flat surfaces. Good for heat loss or compression efficiency study of piping.	**$63**	
OL-705-PP	**Air Temperature.** Stainless steel probe suitable for test rooms, incubators, remote air readings, monitoring of gas streams, etc.	**$73**	
OL-703-PP	**Tubular.** Stainless steel probe for rugged duty. Often used for liquid immersion. Probe is immersible only to cap.	**$70**	
OL-710-PP	**Tubular with Fitting.** Rugged, stainless steel probe with pipe fitting. Suitable for taking readings in pipes or inside closed vessels.	**$75**	

Precision Digital Thermistor Thermometer



$390

Model 5800-2

This lightweight portable digital, powered by either the internal rechargeable battery pack or 115/230 VAC, offers versatility, accuracy, and high repeatability to the user measuring lower temperatures. Four push button selectable ranges cover from −30.0° to 100°C and from −22.0° to +199.9°F with 0.1° resolution. Two input jacks on the rear of the instrument accept any of the Series 700 thermistor probes shown on Page F-13. Either of the two probe temperatures can be displayed by push button selection. An optional rugged leather carrying case is available for transporting the instrument and probes throughout the plant. Each instrument is built with first quality components and includes a 100 hour burn-in and second calibration check before shipment. Included with each instrument is a matched set of Ni-Cad batteries, battery charger switchable for either 115 VAC or 230 VAC operation, and an instruction manual.

Features

- **0.1° Resolution**
- **°C or °F Readout**
- **Two Sensor Input — Switch selectable**
- **For 700 series thermistor sensors**
- **Four Ranges — Switch selectable**
- **Portable — for both AC and DC operation**
- **Internal rechargeable Ni-Cad batteries**
- **Battery charger included**

OMEGA ENGINEERING, INC. STAMFORD, CONN
18.3F
on
celsius
-30 50°
0 100°
fahrenheit
-22 122°
32 199°
thermometer 5800
probe
1
2

$390

General Specifications

Model	Range	Resolution & Repeatability	Accuracy @23°C±3°C 85% r.h.	Probe Inputs Switch Selected	Sensors	Price
5800-2	−30.0°C to +50.0°C	0.1°C or F Switch Selected	±0.5°C	Two Rear Panel Input Jacks	700 Series Thermistors	$390
	0.0°C to +100.0°C		±0.6°C			
	−22.0°F to +122.0°F		±0.75°F			
	+32.0°F to +199.0°F		±0.8°F			

General Specifications

Sensor	700 Series thermistor
Maximum Error Due to Lead Resistance	0°C to +100°C — .0019°C/ohm +32°F to +200°F — .0034°F/ohm −30°C to + 50°C — .0015°C/ohm −22°F to +122°F — .0027°F/ohm
Common Mode Rejection	DC - 120 dB (infinite when operating from batteries) 50/60 Hz - 100 dB
Normal Mode Rejection	60 dB at 50/60 Hz
Response Time (excluding probe)	Less than 800 ms
Temperature Coefficient	±0.025°C/C
Display	LED 0.4″ high
Polarity Indication	Automatic "+" or "−" sign displayed
Sample Rate	2 per second, nominal
Power Requirement	In-Line Charger 115/230 VAC 50/60 Hz, 2VA Nominal
Battery Capacity	7 hours typical, continuous operation. 16 hours recharge from full discharge.
Dimensions	2.43″ H x 7.25″ W x 7.93″ D (5.9 cm H x 18.75 cm W x 20.1 cm D)
Weight	2 lb (0.9 Kg)

To Order Specify: Model 5800-2.

Options and Accessories

Option "R"	**Linearized analog output 6.4mv/°C or °F. This is not a field installable option. To order add suffix "R" to model number.**	**Price: $100**
P/N 7010	**Leather carrying case includes 2½″ x 2½″ x 6½″ storage area for probe. To order add suffix 7010 to model number.**	**Price: $75**

Replacement items (Non-Warranted)

P/N 48-17477	**Battery Pack**	**$50**
P/N 89-17395	**Battery Charger**	**$40**

Series 700 Probes **See page F-14**

Discount Schedule:

1-4 units	**Net**
5-9 units	**2%**
10-19 units	**6%**
20-49 units	**10%**

The OMEGA Family of HAND HELD DIGITAL THERMOMETERS

See Section C

Thermistors
Thermocouples
RTDs
25.0
MODEL 700C
THERMISTOR THERMOMETER
RANGE 30.0 C to 100.0 C
OMEGA ENGINEERING INC
THERMOCOUPLE DIGITAL THERMOMETER
°F
99
°C
HH-99J
OMEGA ENGINEERING, INC.
100.0 C
HOLD
OFF
°F
°C
°C
MODEL 727C
THERMOCOUPLE THERMOMETER
TYPE K CHROMEL ALUMEL
OMEGA ENGINEERING INC
1999
1167 °F
577
MODEL 737CF
PLATINUM THERMOMETER
OMEGA ENGINEERING INC
1200 C
450 AKT

Model 700C
Thermistor
Thermometer
Page C-24
$169

Model HH-99J
Type J
Thermocouple
Thermometer
Page C-21
$99

Model 450 ATH
Thermistor
Thermometer
Page C-19
$275

Model 727C
Type K Thermocouple
Thermometer
Page C-23
$149

Model 871
Type K Thermocouple
Thermometer
Page C-7
$225

Model 450 APT
RTD Thermometer
Page C-19
$275

Model 450 AKT
Type K
Thermocouple
Thermometer
Page C-18
$275

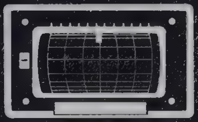
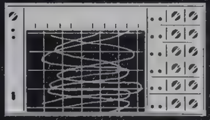
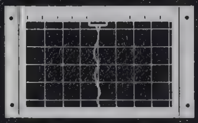
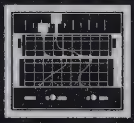
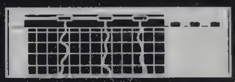
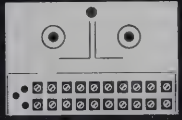
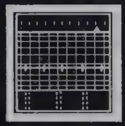
Model 737CF
RTD Thermometer
Page C-24
$179

OMEGA
Omegaline Recorder
THERMOCOUPLE THERMOMETER
THERMOCOUPLE THERMOMETER
THERMOCOUPLE THERMOMETER
OMEGA
OMEGA
ZERO
POWER
CHART SPEED

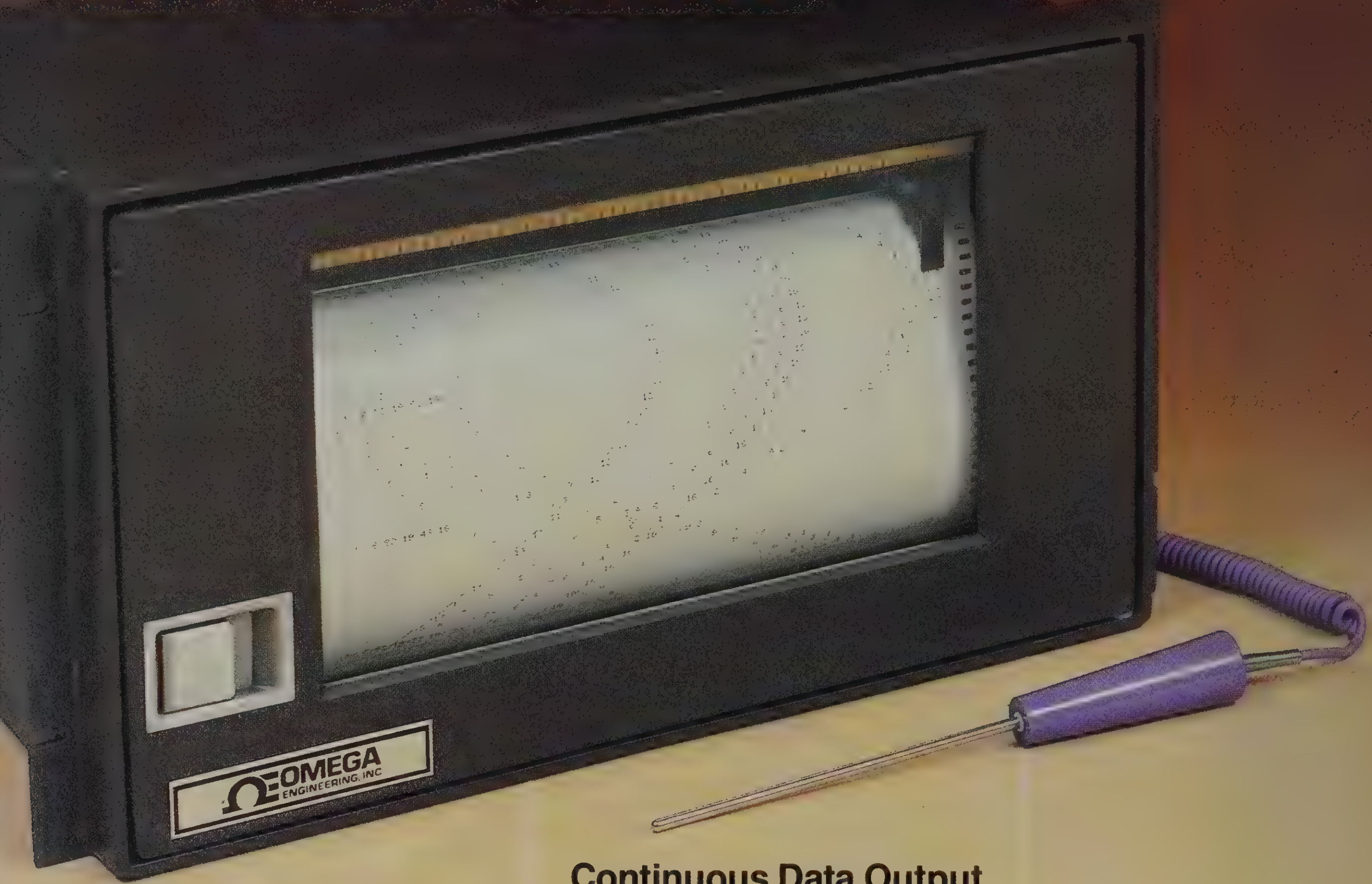
OMEGA
OMEGA Engineering

N

Recorders

Series 270 Trend Recorders/Data Loggers		N-3
OMEGALINE ™ 600 1, 2, 3 & 6 Channel Temperature/mV Recorders		N-9
TAC-386 Thermocouple to Analog Converter NEW		N-23
1 and 2 Channel Vertical Recorders 100 and 250 mm Charts		N-27
Models 145/146 1 and 2 Channel Thermocouple and mV Recorder NEW		N-29
Models 1201/1202 1 and 2 Channel Digital Thermometer and mV Recorder NEW		N-33
Model 156 Compact Flatbed Recorders 125 mm Charts		N-35
Series 500 1, 2 and 3 Channel mV Recorders		N-36
OMEGALINE™ Series 5000 1 and 2 Channel mV Recorders		N-40
RI-5000 Thermocouple/Recorder Interface NEW		N-46
10 Channel Scanners		N-50
Series 180A Linear Multichannel Process Recorder NEW		N-52
ChartTemp™ Battery and Spring Wound Temperature/Humidity Recorders NEW		N-56

The Series OM-270
More than a Recorder



Continuous Data Output on Passive ASCII Port.

Model OM-270
$3,450

32 Programmable Channels

The OM-270 and OM-271 recorders meet most process and laboratory applications by utilizing the versatility in signal conditioning that only a microprocessor can provide. Each channel can be individually programmed for range and sensor type without the need for range cards or special hardware. The parameters of any channel may be changed at any time by a command from the keyboard. Cold junction compensation and linearization are included for thermocouples as well as linear voltage scales for other types of sensors. Connection of all 32 channels is accomplished at an isothermal terminal strip at the rear of the instrument.

The design gives the user optimum performance in a dependable and serviceable package. To maximize reliability, mechanical parts have been kept to a minimum; only the chart drive and thermal print head assembly contain moving parts.

OM-270 FEATURES

- **Microprocessor Control**
- **32 Channel Trend Recording**
- **Thermocouple Input— J, K, T, E, R, S and N**
- **Automatic Self-calibrati**
- **Operator Selectable Ranges**
- **Real Time Clock**
- **Alarms—High and Low Each Channel**
- **Continuous Serial ASCII Data Output**
- **Thermal Printing**

Records Trends
Records Data

0 10 20 30 40 50 60 70 80 90 100
OPERATE
STANDBY
AUTO
OMEGA
ENGINEERING, INC.

emote Programming
tandard!

M-271 Includes All of
e OM-270 Features
LUS:

Data Log Mode

Conditioning for B, C, G, D
nd Platinel II
Thermocouples

00Ω Platinum RTDs
α = .00385 and .003923

Δ T Mode

Alarm Mode Chart and
Print Rates

Keyboard Lockout
Password

Remote ASCII
Programming

°F or °C Readout

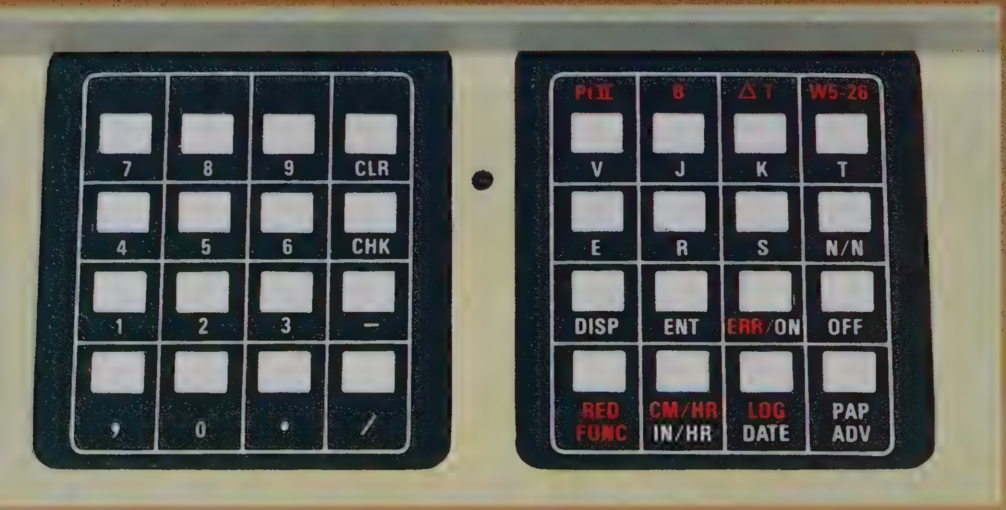
Model OM-271
$4,100

Trend or Data Display

Both models record the trend of every selected channel in under 2 second cycles. In addition, the Model OM-271 can be converted into a data logger either from the keyboard or remotely. In this mode, the input signals are digitized and printed in a five column format across the chart. A printout of all 32 channels takes approximately 60 seconds and includes the date and time. Print frequency can be programmed from once each minute to once every 5000 minutes.

All 32 channels are scanned every 2 seconds and compared to the stored alarm values. When an alarm is detected, either the high or low alarm relay is immediately activated. During every scan cycle, the internal reference source is used to check both zero and full scale values and make calibration adjustments automatically if needed.

The Series OM-270
Under $130 per Channel



Easy to program—Easy to use!

1	2	3	4	5	6	7	8	9
ID /	Left /	Right /	Low /	High /	Filt /	Range /	Type	Ent

A simple plain-language character string programs a channel in nine easy steps. A slash separates parameters in the following sequence:

1 ID/ The channel number being programmed.

2 Left/ The signal value at the left margin on the chart.

3 Right/ The signal value at the right margin on the chart.

The microprocessor linearly scales the chart for this range.

4 Low/ The value for low level alarm.

Operate Mode

In the OPERATE mode, the chart paper moves at a speed selected by the operator and the date and time of day are printed on the chart every 2 inches. All 64 alarm set points and 32 input signals are scanned every 2 seconds and at high chart speeds, all 32 channels are printed in less than 10 seconds.

5 High/ The value for high level alarm. (The alarms are entered as a percentage of the specified range.)

6 Filter/ Number of most recent readings to be averaged to reduce noise.

7 Range/ An operator selectable range can be specified, or selection can be left to the microprocessor to select the amplifier with the highest gain.

8 Type/ Thermocouple type or linear voltage.

9 Ent/ The Enter command activates the parameters that you have just specified.

Standby Mode

In the STANDBY mode, the recorder does not print or advance the chart paper, but all 64 alarms are scanned every 2 seconds and the high or low alarm relays close if an alarm occurs. This mode is only used during periods when no printed record is required. For temporary shutdowns, this mode is recommended in lieu of turning OFF the main power switch on the rear panel.

OPERATE
STANDBY
AUTO

OM-270 Automatic Mode

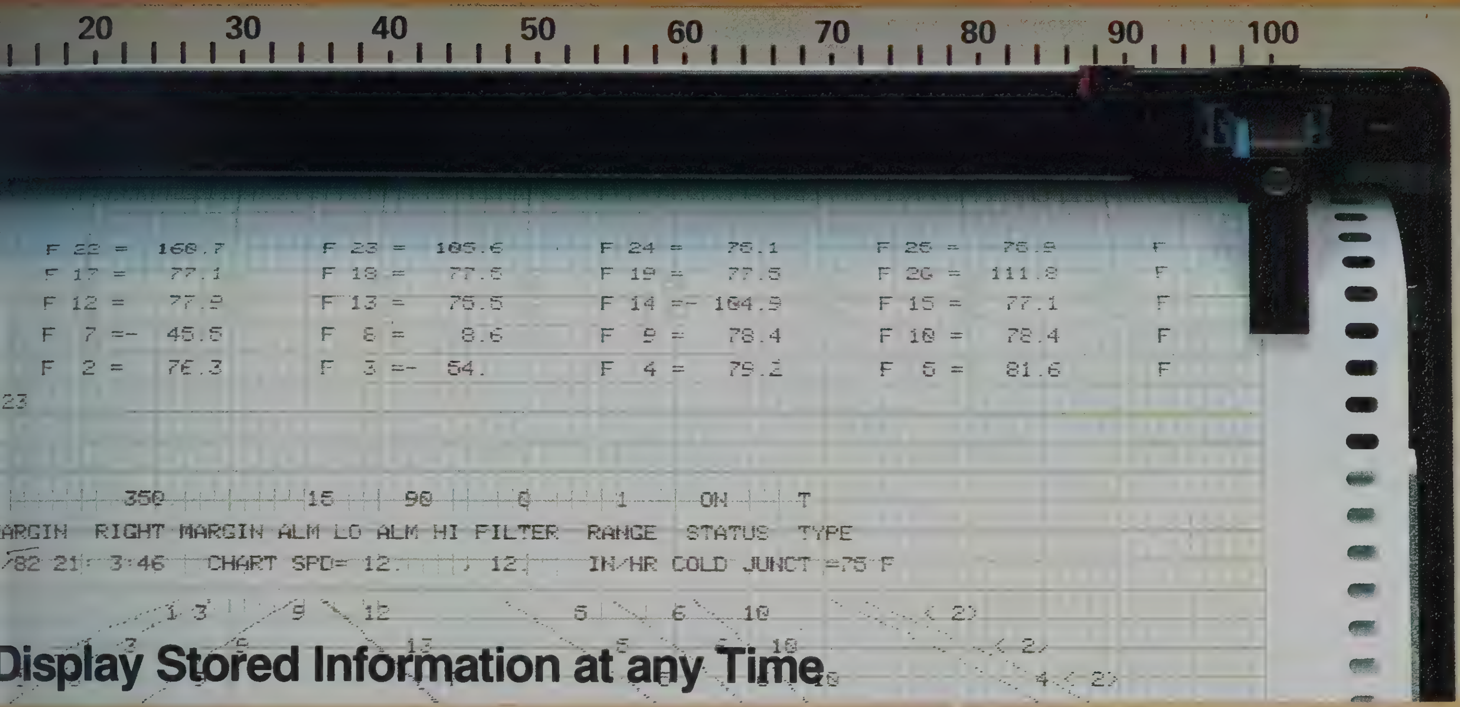
In the OM-270 AUTOMATIC mode, the recorder functions as in the STANDBY mode except that the chart paper will not advance until an alarm occurs. When any of the 64 alarm set points are exceeded, the recorder will then print the date and time of the alarm on the chart and begin to drive the chart at the speed preprogrammed by the operator until the alarm condition ends.

OM-271 Automatic Mode

In the OM-271 AUTOMATIC mode, the recorder functions as in the OPERATE mode except that the operator can select one chart speed for normal conditions and a second speed for alarm conditions. When an alarm occurs, the recorder automatically prints the Date/Time on the chart, switches to a preselected higher chart and print speed, and operates at the higher speed for the duration of the alarm or until all channels in alarm are printed at least once within brackets.

OM-270
$3,450
OM-271
$4,100

All Features are Standard!



```
  F 22 =  160.7        F 23 =  105.6        F 24 =   75.1        F 25 =   75.9        F
  F 17 =   77.1        F 18 =   77.5        F 19 =   77.5        F 26 =  111.8        F
  F 12 =   77.9        F 13 =   75.5        F 14 =- 104.9        F 15 =   77.1        F
  F  7 =-  45.5        F  8 =    8.6        F  9 =   78.4        F 10 =   78.4        F
  F  2 =   76.3        F  3 =-  54.         F  4 =   79.2        F  5 =   81.6        F
23

        350          15      90        0        1        ON       T
ARGIN  RIGHT MARGIN ALM LO ALM HI FILTER  RANGE  STATUS  TYPE
/82 21: 3:46   CHART SPD= 12.       12     IN/HR COLD JUNCT =75 F
```

Display Stored Information at any Time

Channel Interrogation—The operator can display the data entered for any or all channels at any time. The printed display lists all channel parameters plus Date/Time, Chart Speed, and the Cold Junction Temperature. When the Interrogation printout is completed, the recorder will return to its original recording or logging functions.

Channel Identification—The channel ID number is printed approximately every 1/4" and just to the right of the data points. Intersecting lines or identical values are always traceable because the recorder will not print channel identification numbers on top of each other. Channel ID numbers will be printed in turn and all channels in alarm have priority for printing.

Left/Right Margins—The operator determines which left and right margins best fit each channel application. The margins can be negative or positive and zero can be set anywhere on the chart. The recorder will automatically select the optimum amplifier range for best accuracy unless it is manually overridden. Margins may be changed for any channel at any time.

Alarm Set Point—The 32 high and 32 low alarm set points are expressed as a percentage of full scale and may be different values for each channel. Normally open (N.O.) contacts will close when the high or low set point values are exceeded.

Input Signal Filter—Operator selectable for each channel and only required in extreme situations. For very noisy data signals, this feature calculates the average value of the most recent of 1 to 15 data samples.

Range Selection—The operator can select one of five ranges or allow the recorder to automatically select the optimum range when the operator specifies the left and right margins.

Status—Channels turned OFF will not be printed on the chart. Turning a channel OFF will not affect any of the other parameters so the operator can turn channels ON and OFF without any other program changes.

Type of Input—Shows the thermocouple type or voltage programmed for each channel. Operator can reprogram input types at any time.

Date and Time—Day, month, year, hour, and minute are printed every two inches of chart. The recorder automatically adjusts at each month end, year end, and leap year. Operator can elect to also have Date/Time automatically printed on the chart when an alarm condition occurs.

Chart Speed—Adjustable in increments of 0.01 from 0.01 in/hr to 120 in/hr (or metric equivalent) and all settings in between; literally thousands of different chart speeds.

Cold Junction Compensation—The cold junction temperature is continuously monitored and used to compensate the thermocouple signal.

Trend Recording—All channels in alarm will have brackets printed around the channel ID number for the duration of the alarm condition. In the case of multiple alarms, each alarm point will be printed in brackets at least once, even if the alarm condition continues for only a few seconds.

Data Logger—In addition to trend recording, the Model OM-271 can also be operated as a data logger, with the input signals listed numerically on the chart in a 5 column format across the entire 10" chart width. The channel ID number, alarm status, and the input signal value in volts or degrees are printed for all channels that are turned on.

The Series OM-270

Mechanically Uncomplicated

Versatile Electronics

To maximize reliability, mechanical parts have been kept to a minimum. All moving parts are contained in the chart drive and print head assemblies. The print head is a plug-in and is replaceable from the front of the recorder with the removal of one mounting screw. The use of a reliable solid state print head and thermal chart paper eliminates the need for inking or pen replacement. The only moving parts in the print head system are one motor, one gear and a steel reinforced drive chain. The remainder of the moving parts are in the chart drive, consisting of a stepping motor, four gears, and a clutch.

The door of the metal enclosure is removable and the unit can be either rack, panel, or bench mounted.

All other operating components are contained in the electronics section which consists of a keyboard, input board, and digital processor board. The unit is totally and continuously self-calibrating with the exception of the cold junction compensation for which a rear panel adjustment is provided. All amplifiers are digitally calibrated every two seconds by scanning a reference after each scan of active channels. These features, combined with the per-channel digital filtering and serial ASCII communications make the Series OM-270 an extremely versatile and reliable tool for a broad range of applications.

Common Specifications

Inputs:
32 Channels

Memory:
Battery backup of programmed parameters for 5 years

Output:
300 Baud Serial ASCII (passive)

Span:
1 mV minimum, 10 Volt maximum

Accuracy:
<0.3% of full scale for all ranges of 10mV or more.
<1% of full scale for 1mV span.

Automatic Calibration:
Contains a built-in precision reference source and automatica checks both zero and full scale every two (2) seconds and makes adjustments if needed.

All Features Are Standard! Electronically Simple

- Add WB-DC27 Converter for RS-232C Compatibility.

Scan Cycle Time:
Scans all input signals and alarm set points every two (2) seconds

Print Cycle Time:
All 32 channels can be printed in less than 10 seconds in trend mode

Chart Speeds:
Keyboard selectable from 0.01″/hour to 2″/minute in 0.01″ increments or the metric equivalent

Alarm Contacts:
One common SPDT contact closure is provided for high alarms and one for low alarms. The contacts are rated 0.5 amps @ 110 V ac, non-inductive.

Common Mode Rejection Ratio:
Better than 120 dB

Common Mode Voltage:
±15 volts maximum

Input Impedance:
Greater than 1 Megohm at dc

Mounting:
Ready to install in any 19″ rack or may be panel mounted with an optional jack screw kit. Requires 10¼″ x 17¼″ cutout (26.0 mm x 43.8 mm). Rubber feet are included for benchtop application.

Dimensions:
H: 10.50″ (267 mm) x W: 19″ (483 mm) x D: 11.25″(286 mm).

Weight:
Net 36 lbs. (16 kg). Shipping weight 48 lbs. (22 kg).

Operating Temp:
32°F to 120°F (0°C to 49°C)

Power Requirements:
Less than 50 Watts. Specify **100 - 120 V or 200 - 240 V.** Operates on 50 or 60 Hz

Accessories

Model OM-JS27 Panel mount jack screw kit	**$75**
Model WB-DC27 Serial ASCII to RS-232 converter	**$175**

Supplies

Chart Paper, 100 foot roll
Part Number OM-TR27E (English)
OM-TR27M (Metric)

1 to 24 rolls	**$18**/roll
25 to 99	**15**/roll
100 and up	**13**/roll

To Order:

OM-270 $3,450

- **J, K, T, E, R, S, and N Thermocouples**
- **Program Error Indication**
- **°C Readout**
- **Stop or Run in Auto Mode**
- **ASCII Serial Output**

OM-271 $4,100

- **J, K, T, E, R, S, B, G, C, D, N, and Pt II Thermocouples plus ΔT Function**
- **Program Error Prompting**
- **°F or °C Readout**
- **Two Speeds in Auto Mode**
- **Keyboard Locked Without Password**
- **Five Column Data Log Mode**
- **Remote Programming Through ASCII Input**

Temperature/mV Recorders

OMEGALINE™ Series

The Recorders of the Future — NOW!

OMEGA
ENGINEERING, INC.
STAMFORD CONN

For more information on the OMEGA Thermocouple to Analog Convertor (TAC), see page N-23.

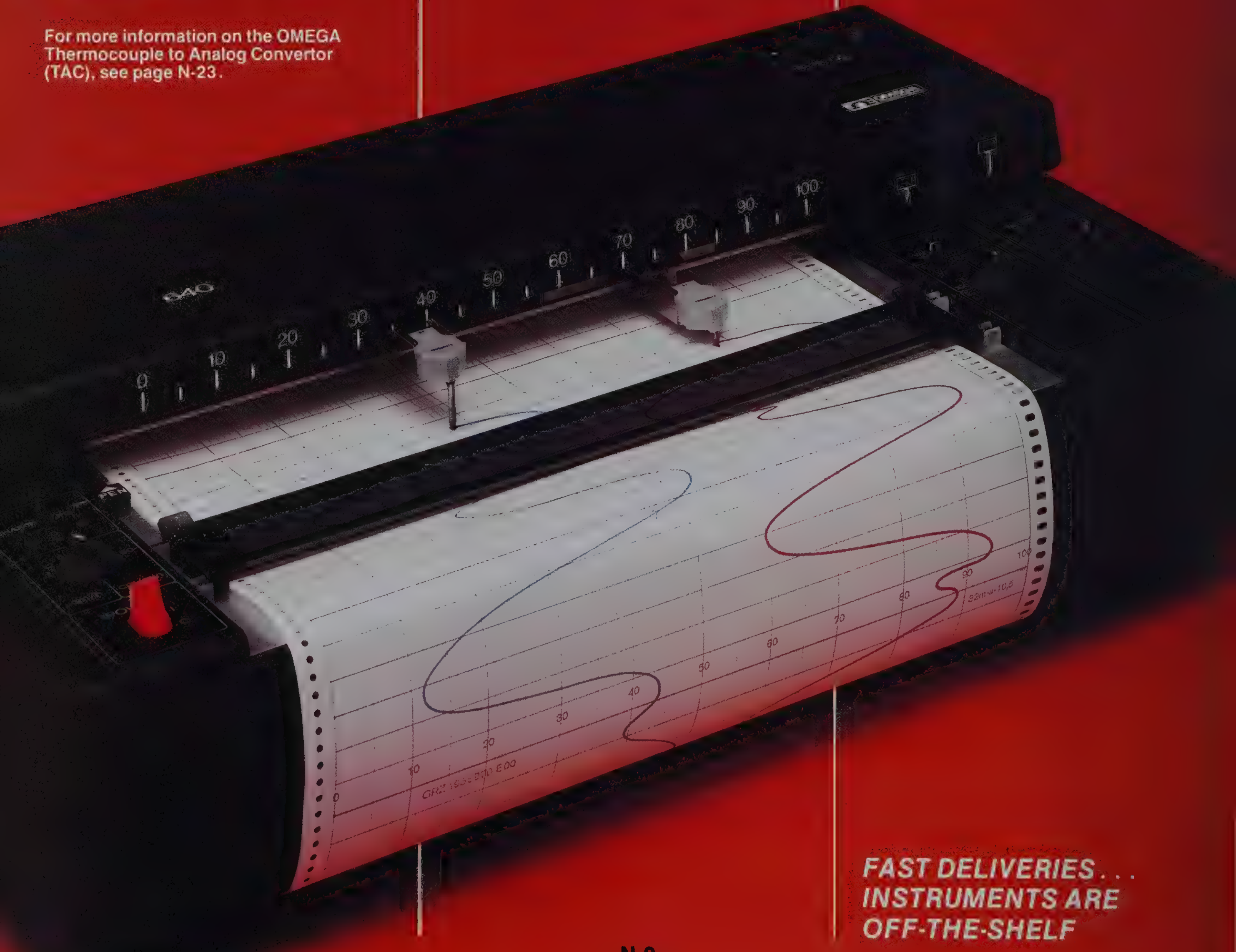
Now a complete series of precision instruments designed by F.A. Porsche for OMEGA ENGINEERING, INC.

- Thermocouple Inputs — J and K
- Electronic Linearization
- Temperature Accuracy 1.5% F.S.
- Millivolt Inputs 10 mV to 100 V

Model 640

High Performance Flatbed Recorder 1 and 2 channels, Prices from:

$850


640
0
10
20
30
40
50
60
70
80
90
100

FAST DELIVERIES . . .
INSTRUMENTS ARE
OFF-THE-SHELF

Temperature Recorders
OMEGALINE™ Series

Model 630
Compact Vertical Recorder
1, 2, and 3 channels,
Prices from:

$825

630
OMEGA
VAR
CAL
mV
620
OMEGA
SPAN 200 °C
ZERO SHIFT °C

Model 620
Low Profile Vertical Recorder
1 and 2 channels,

Prices from:

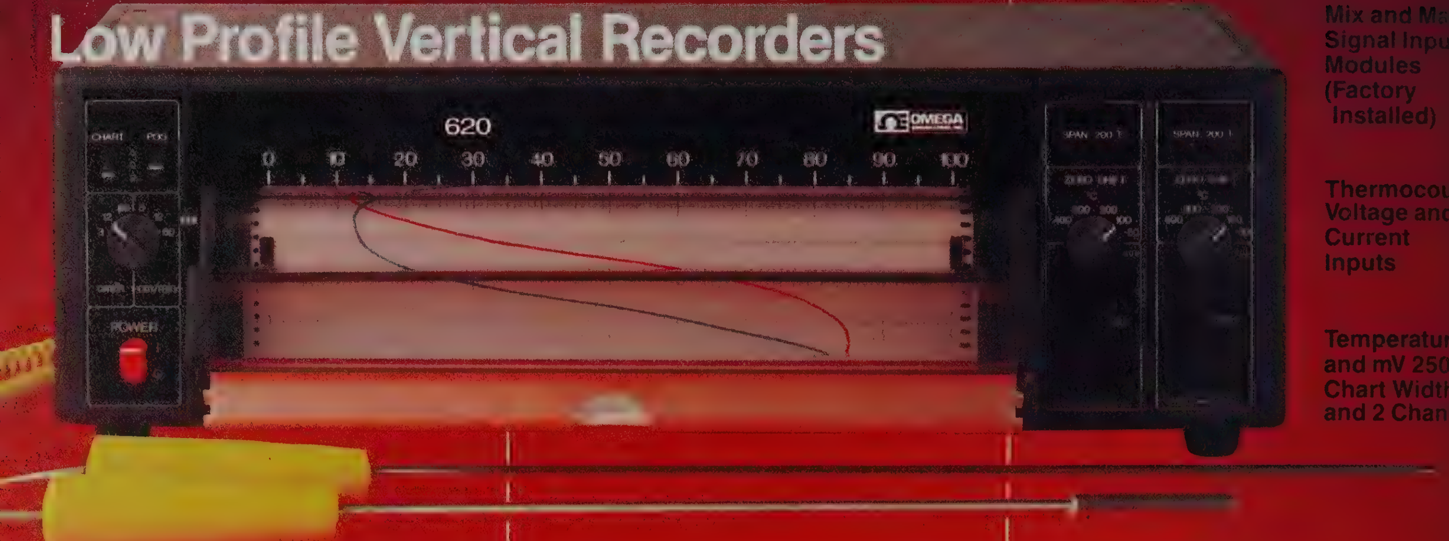
$1,095

- Thermocouple Inputs — J and K
- Millivolt Inputs — 10 mV to 100 V
- Electronic Linearization
- Temperature Accuracy — 1.5% F.S.

Temperature Recorders

OMEGALINE™ 620

Low Profile Vertical Recorders



Mix and Mat
Signal Inpu
Modules
(Factory
Installed)

Thermocoupl
Voltage and
Current
Inputs

Temperature
and mV 250 m
Chart Width 1
and 2 Channel

TEMPERATURE

- Thermocouple types J and K
- Electronic Linearization
- Cold Junction Compensation
- 1.5% Accuracy F.S.
- Calibrated Zero Offset

SPAN 200°C
ZERO SHIFT
°C
400 300 200 100 50
TYPE K Ni-Cr/Ni-Al

J Iron-Constantan

or

K Chromel-Alumel

200°C Span
Five Ranges:

– 50 to 150 °C
100 to 300 °C
200 to 400 °C
300 to 500 °C
400 to 600 °C

Module J or K **$280**

EASY TO USE!

Just connect your thermocouple probe (sensor) to the input and the OMEGALINE™ does the rest. You get direct temperature readings! Cold Junction Compensation and Linearization are handled by the precision electronics. Temperature readout in 200°C increments on linear chart paper.

The OMEGALINE™ Temperature Recorder will work with any type J or K thermocouple probe. For more information on thermocouple probes, consult sales department. (Match probe type to instrument type thermocouple).

STATE-OF-THE-ART FEATURES

- Direct Temperature Readout
- Quartz-controlled 6-speed chart drive 3, 12, 60 cm/hr, cm/min

QUALITY

- Backed by 20 years of OMEGA ENGINEERING experience
- Rugged, scratch-resistant case
- Fully enclosed front cover to keep dust out and quality in
- Tilt stand carrying handle

VALUE

- Precision instrumentation at an economical price
- Easy-to-replace disposable pens
- Z-fold or roll paper
- 250 mm recording width

NEW MODULES!

MODULE V

- **17 mV & V Ranges**
- **Up to 200% Zero Offset in Steps**

MODULE V **$200**

MODULE CV

- **20 Current & Voltage Ranges**
- **AC/DC Ranges**

MODULE CV **$190**

Call Sales Department for Information

MILLIVOLTS

- Fixed and Variable Gain 1 mV to 100 V Full Scale
- – 5% To 105% Cont. Zero Offset
- 0.5% Accuracy
- 0.2% Linearity
- High Input Impedance

VAR
CAL
V
mV
10
1
100
10
100

mV
Five Ranges

10mV
100mV
1 V
10 V
100 V

Variable Gain: Amplify input up to 2½ times.

Module mV **$135**

HOW TO ORDER

1. Select base chassis with number of channels required.
2. Choose module(s).
3. Price is base chassis plus modules.

1 CHANNEL Model 620-1-[*]	**$980** plus module
2 CHANNEL Model 620-2-[*]-[*]	**$1,380** plus modules

[*] insert module type(s)
J, K, V, mV, CV

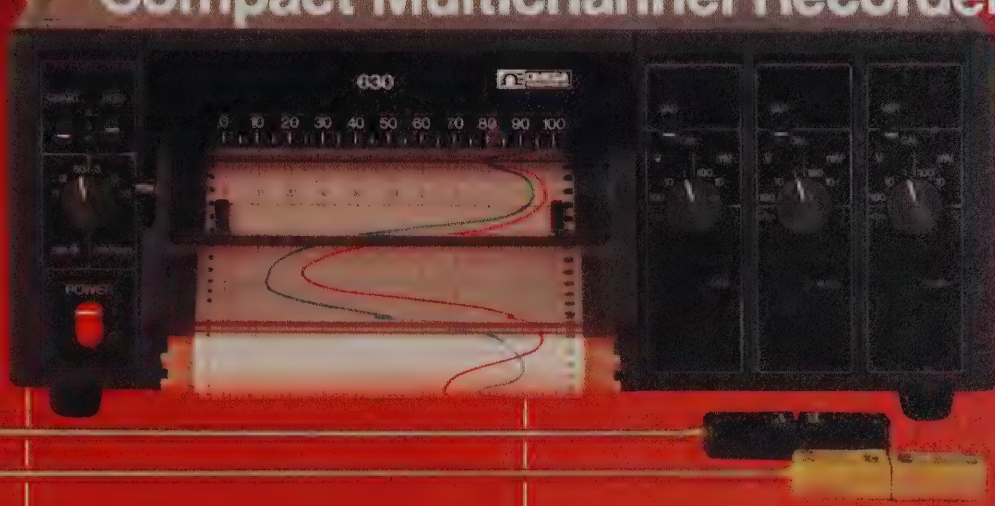
Example: 620-1-mV **$1,115**

Temperature Recorders
OMEGALINE™ 630
Compact Multichannel Recorder

Mix and Match Signal Input Modules (Factory Installed)

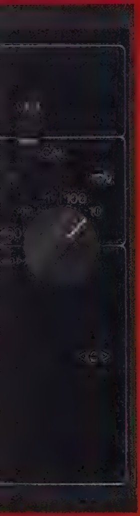
Thermocouple Voltage and Current Inputs.

Temperature and mV 120 mm Chart Width, 1, 2, and 3 Channels



ILLIVOLTS

Fixed and Variable Gain 1 mV to 100 V Full Scale
– 5% To 105% Cont. Zero Offset
0.5% Accuracy
0.2% Linearity
High Input Impedance



mV
Five Ranges
10mV
100mV
1 V
10V
100V

Variable Gain: Amplify input up to 2½ times.

Module mV	**$135**

HOW TO ORDER

1. Select base chassis with number of channels required.
2. Choose module(s)
3. Price is base chassis plus modules.

1 CHANNEL Model 630-1-[*]	**$690** plus module
2 CHANNELS Model 630-2-[*]-[*]	**$1,060** plus modules
3 CHANNELS Model 630-2-[*]-[*]-[*]	**$1,410** plus modules

[*] insert module type(s)
J, K, V, mV, CV

Example: 630-1-mV: **$825**

STATE-OF-THE-ART FEATURES

- Direct temperature readout
- Quartz-controlled 6-speed chart drive 3, 12, 60 cm/hr, cm/min
- 3 Channels in a compact case

QUALITY

- Backed by 20 years of OMEGA ENGINEERING experience
- Rugged, scratch-resistant case Fully enclosed front cover to keep dust out and quality in
- Tilt stand carrying handle

VALUE

- New advanced design allows large recorder features in a compact package
- Easy-to-replace disposable pens
- Z-fold or roll paper
- 250 mm recording width

NEW MODULES!

MODULE V

- 17 mV & V Ranges
- Up to 200% Zero Offset in Steps

MODULE V **$200**

MODULE CV

- 20 Current & Voltage Ranges
- AC/DC Ranges

MODULE CV **$190**

Call Sales Department for Information

TEMPERATURE

- Thermocouple types J and K
- Electronic Linearization
- Cold Junction Compensation
- 1.5% Accuracy F.S.
- Calibrated Zero Offset

SPAN 200 °C
ZERO SHIFT
°C
400
300
200
100
50
TYPE K Ni-Cr/Ni-Al

J Iron-Constantan
or
K Chromel-Alumel

200 °C Span
Five Ranges:
– 50 to 150 °C
100 to 300 °C
200 to 400 °C
300 to 500 °C
400 to 600 °C

Module J or K	**$280**

EASY TO USE!

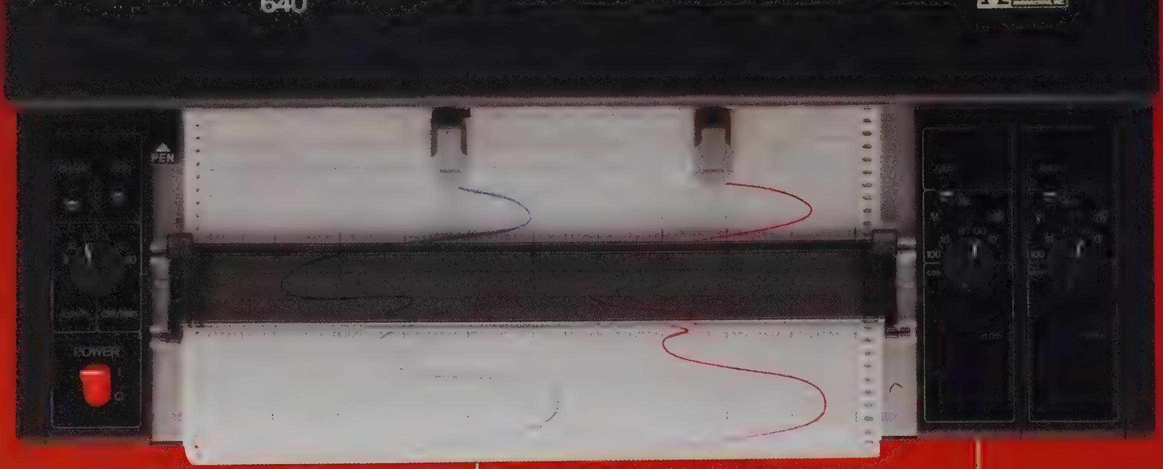
Just connect your thermocouple probe (sensor) to the input and the OMEGALINE™ does the rest. You get direct temperature readings! Cold Junction Compensation and Linearization are handled by the precision electronics. Temperature readout in 200°C increments on linear chart paper.

The OMEGALINE™ Temperature Recorder will work with any type J or K thermocouple probe. For more information on thermocouple probes, consult sales department. (Match probe type to instrument type thermocouple).

Temperature Recorders

OMEGALINE™ 640

Single and High Performance Flatbed



NEW!

TEMPERATURE

- Thermocouple types J and K
- Electronic Linearization
- Cold Junction Compensation
- 1.5% Accuracy F.S.
- Calibrated Zero Offset

SPAN 200 °C
ZERO SHIFT
°C
300
200
400
100
50
TYPE K

J **Iron-Constantan**

or

K **Chromel-Alumel**

200 °C Span
Five Ranges:
– 50 to 150 °C
100 to 300 °C
200 to 400 °C
300 to 500 °C
400 to 600 °C

Module J or K	**$280**

EASY TO USE!

Just connect your thermocouple probe (sensor) to the input and the OMEGALINE™ does the rest. You get direct temperature readings! Cold Junction Compensation and Linearization are handled by the precision electronics. Temperature readout in 200°C increments on linear chart paper.

The OMEGALINE™ Temperature Recorder will work with any type J or K thermocouple probe. For more information on thermocouple probes, consult sales department. (Match probe type to instrument type thermocouple).

STATE-OF-THE-ART FEATURES

- Direct temperature readout
- Quartz-controlled 6-speed chart drive 3, 12, 60 cm/hr, cm/min

QUALITY

- Backed by 20 years of OMEGA ENGINEERING experience
- Rugged, scratch-resistant case
- Fully enclosed front cover to keep dust out and quality in
- Tilt stand carrying handle

VALUE

- Precision instrumentation at an economical price
- Easy-to-replace disposable pens
- Z-fold or roll paper
- 250 mm recording width

NEW MODULES!

MODULE V

- **17 mV & V Ranges**
- **Up to 200% Zero Offset in Steps**

MODULE V	**$200**

MODULE CV

- **20 Current & Voltage Ranges**
- **AC/DC Ranges**

MODULE CV	**$190**

Call Sales Department for Information

MILLIVOLTS

- Fixed and Variable Gain 1 mV to 100 V Full Scale
- – 5% To 105% Cont. Zero Offset
- 0.5% Accuracy
- 0.2% Linearity
- High Input Impedance

VAR
CAL
V
mV
1
100
10
10
100

mV

Five Ranges:
10mV
100mV
1V
10V
100V

Variable Gain:
Amplify input
up to 2½ times.

Module mV	**$135**

HOW TO ORDER

1. Select base chassis with numbers of channels required.
2. Choose module(s).
3. Price is base chassis plus modules.

1 CHANNEL Model 640-1-[*]	**$760** plus module
2 CHANNELS Model 640-2-[*]-[*]	**$1,190** plus modules

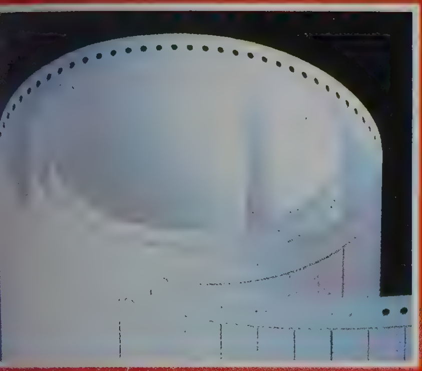
[*] insert module type(s)
J, K, V, mV, CV

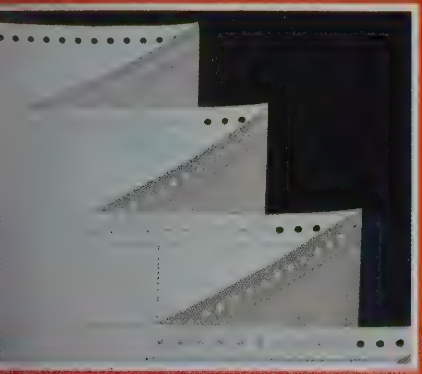
Example: 640-1-mV **$895**

Temperature Recorders
OMEGALINE™ Accessories and Options

CCESSORIES:

APER





ODELS 620, 640
oll Chart, Linear, 250 mm
wide, 32 m long

L-RP-1	1 Roll	$ 8
L-RP-10	10 Rolls	65
L-RP-25	25 Rolls	145

ODEL 620
Fold Pack, Linear, 250 mm
ide, 16 m long

L-ZP-1	1 Pack	$ 8
L-ZP-10	10 Packs	65
L-ZP-25	25 Packs	145

ODEL 630
oll Chart, Linear, 120 mm
wide, 32 m long

-SRP-1	1 Pack	$ 8
-SRP-10	10 Packs	65
-SRP-25	25 Packs	145

-Fold Pack, Linear, 120 mm
wide, 16 m long

L-SZP-1	1 Pack	$ 8
L-SZP-10	10 Packs	65
L-SZP-25	25 Packs	145

ASE

-312	Carry Case Model 620	$140
-313	Carry Case Model 630	140
-314	Carry Case Model 640	140

PENS

SL-302

SL-301

SL-303

PENS:
Disposable Felt Pens
For Models 620, 630, 640
Package of 3 $8

CH1	CH2	CH3
Red SL-301	Blue SL-302	Green SL-303

OPTIONS:

MODELS 620, 630, 640

E-01	Rear Input Option: 8-pin Plug and Terminals (V, mV and CV Modules Only)	$ 18
E-02	Multifunction Option, includes: a) Min-Max Alarm Contacts b) Superimposed Event Marker (V, mV and CV Modules Only) c) Analog Output, 0-10 V FS d) Input Inverter (V, mV and CV Modules Only)	135
E-12	12 V dc Power	115
E-36	Spare 8 Pin Plug	8

MODELS 620, 630 ONLY

E-05	Rack Mount Frame	105
E-07	Front Handles (requires E-05)	45

MODEL 640 ONLY

E-03	Electric Pen Lift	110

SPECIFICATIONS
OMEGALINE™ 620, 630, 640

Chart Accuracy: 30 ppm, 20 to 25 °C; 70 ppm, 0 to 50 °C

Drive Resolution: 0.078 mm per step (128 per cm)

External Chart Control: Pulse, stop, reverse by TTL or CMOS signal

Slew Speed: 50 cm/s

Linearity: 0.25%

Dead Band: 0.5%

Input: Floating, asymmetrical; 250 V max

TEMPCO: The greater of: 0.01%/°C or 5 μV/°C

Input Current: 10 mA max

Thermocouple Inputs: ANSI type J and K

Thermocouple Source Impedance: 1000 Ω max

Cold Junction Error: 0.02%/°C

CMRR ac: > 50 dB
dc: > 90 dB

Protection: VDE 0411 Protection Class I

Voltage: 120/220/240 V ac ± 10% 50-60 Hz

Power: One Channel: 12 VA
Two Channel: 15 VA
Three Channel: 18 VA

Dimensions:
620 H: 5″ (132 mm) × **W:** 17.8″ (450 mm) × **D:** 9″ (225 mm)
630 H: 5″ (132 mm) × **W:** 14.2″ (360 mm) × **D:** 9″ (225 mm)
640 H: 6″ (150 mm) × **W:** 17.3″ (440 mm) × **D:** 10.1″ (270 mm)

Weight:

620	1CH, 15.4 lbs (7 kg) 2CH, 16.5 lbs (7.5 kg)
630	1CH, 13.2 lbs. (6 kg) 2CH, 14.3 lbs (6.5 kg) 3CH, 15.4 lbs (7 kg)
640	1CH, 8.8 lbs (4 kg) 2CH, 10 lbs (4.5 kg)

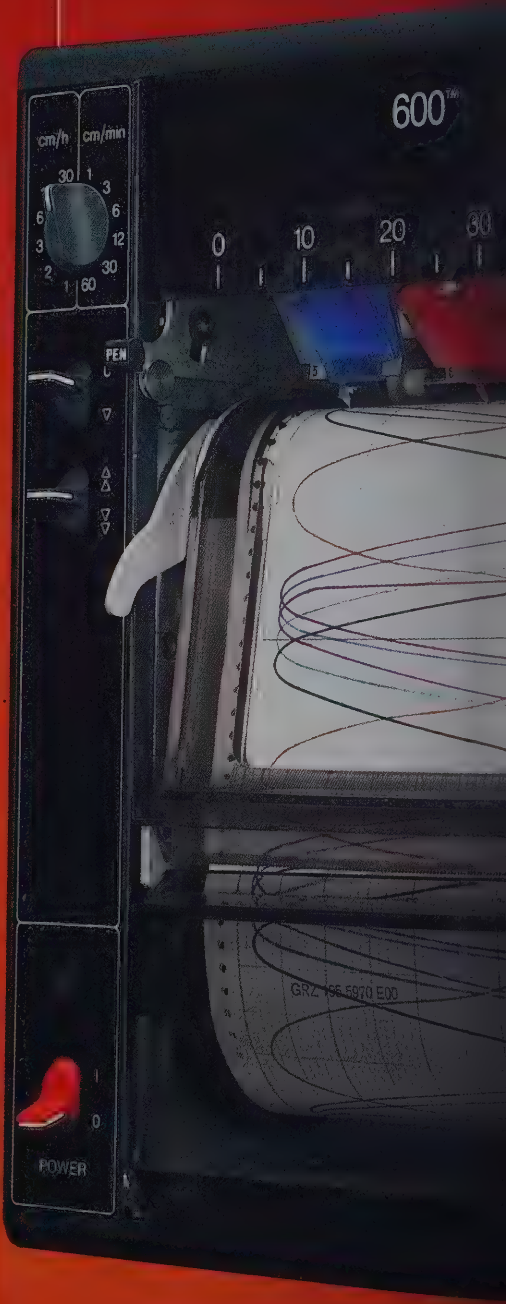
Temperature Recorders
OMEGALINE™ 600/610
The Vertical Recorders of the Future — NOW!

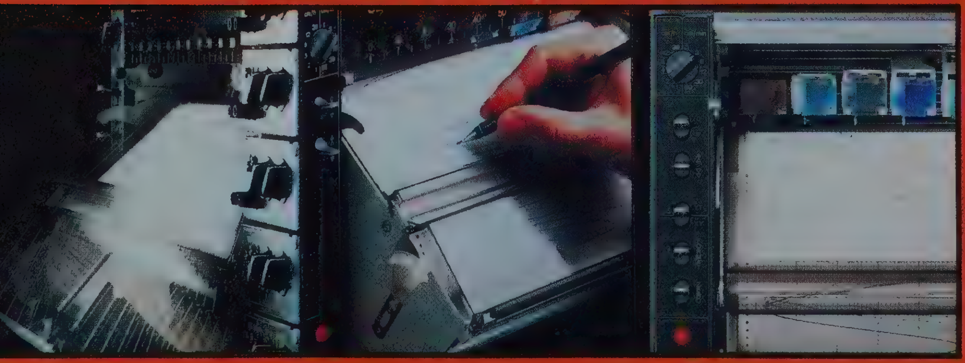
Six Channel Temperature and Laboratory Recorders with interchangeable plug-in modules for:

- **Thermocouples**
- **RTDs**
- **Volts, AC/DC**
- **Amps, AC/DC**
- **Log/Lin**

Special Features:
Every possible feature has been included in the design of the OMEGALINE™ 600 and 610 to provide versatility, high performance, and long-term reliability.

- Recording width 250 millimeters (10″) — Overall accuracy 0.3% — Slew speed 100 cm/sec — Overrange servo shutdown.
- Modular design permits interchangeable input modules and expansion to maximum number of channels.
- Temperature modules for thermocouple types J, K, T, S, B, and Platinum RTD's $\alpha = 0.00385$
- Linearized temperature output signal 1 mV/°C for thermocouple modules and 10 mV/°C for RTD modules.
- Voltage/Current modules with ranges from 50 μV to 200 V dc 10 mV to 20 V ac/dc, and 1 mA to 2 A ac/dc.
- Calibrated zero offset: 5 x 100% manual or 6 x 100% automatic and manual.
- Variable range feature expands scale from 40% to 100% of the calibrated value — Zero adjustment between – 100% and + 100%.
- Electronic event marker — Monitor output 0 to 1 V dc — Input via terminals or 6-pin connector.
- Linear/Logarithmic recording — LOG selection: 0.25, 0.5, 1, and 2 decades.
- Quartz locked chart drive from 1 cm/h to 60 cm/min. — Remote chart drive — Automatic slewing.
- Recording by either ink pens with capillary or felt-nylon tips, or disposable felt pens.
- Roll or Z-fold paper — 0 to 100 grid, 32 meters long.
- Complies with the safety requirements according to VDE-0411 Protection Class 1



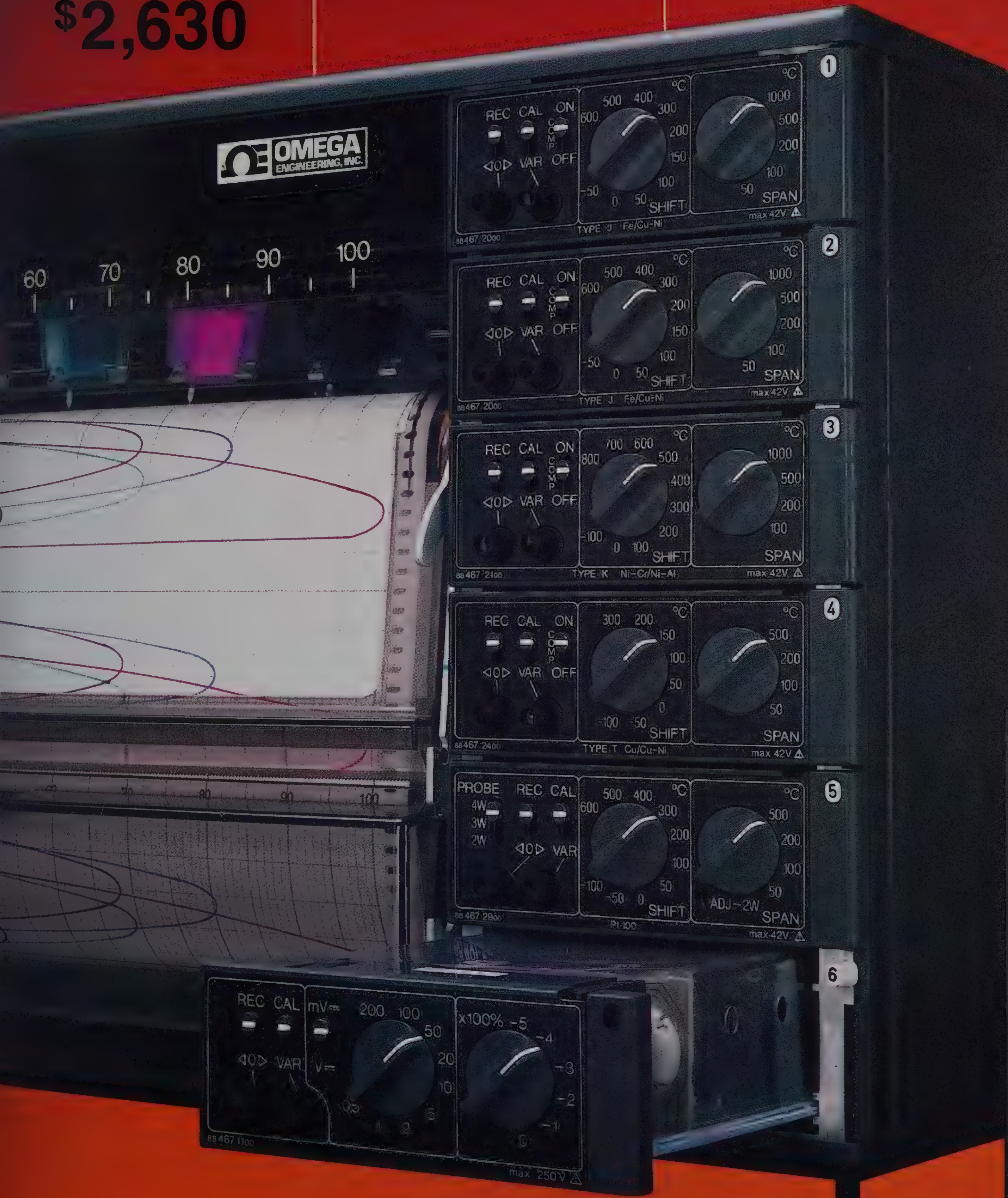


Designed by F.A. Porsche for OMEGA ENGINEERING, INC.

Temperature Recorders
OMEGALINE™ 600/610

Temperature Models Start at

$2,630


OMEGA ENGINEERING, INC.
60 70 80 90 100
①
REC CAL ON COMP OFF VAR
500 400 300 200 150 100 50 0 -50 600 °C SHIFT
1000 500 200 100 50 °C SPAN
TYPE J Fe/Cu-Ni
max 42V
88 467 2000
②
TYPE J Fe/Cu-Ni
③
700 600 500 400 300 200 100 0 -100 800 SHIFT
TYPE K Ni-Cr/Ni-Al
88 467 2100
④
300 200 150 100 50 0 -50 -100 SHIFT
TYPE T Cu/Cu-Ni
88 467 2400
⑤
PROBE 4W 3W 2W
ADJ-2W SPAN
Pt 100
88 467 2900
6
REC CAL mV V VAR
200 100 50 20 10 5 2 1 0.5
x100% -5 -4 -3 -2 -1 0
max 250V
88 467 1100

Temperature Recorders
OMEGALINE™ 600/610

The OMEGALINE™ 600 and **OMEGALINE™ 610** Vertical Chart Recorders have a unique modular design which allows the instrument to be configured to meet the most exacting instrumentation or laboratory requirements. Each channel is fully modular; having its own writing arm, servo-system, and interchangeable measurement range module. The OMEGALINE™ 600 and 610 have an extensive series of interchangeable measurement range modules to fulfill every requirement. They are available for temperature (linearized thermocouples and platinum RTDs), voltage (ac and dc) and current (ac and dc) with fixed and multiple ranges, automatic or manual zero offset and linear or logarithmic representations. The range modules are simple and fast to exchange. The housing is the same for all measurement types. No time-consuming adjustments or calibration are required. This interchangeability allows the instrument to be easily configured to meet every user need and reconfigured as those needs change.

The OMEGALINE™ 600 is a 1 to 6 channel "YT" (input vs. time) recorder which incorporates all the latest electronic components in order to meet the accuracy and performance requirements of instrumentation, laboratory, and R&D use. Its modular design permits the instrument to be field-expanded up to the maximum 6 channels by the addition of writing arm, servo system, and measurement range modules at any time. The basic chassis has all the wiring and power to accommodate the maximum number of channels.

The OMEGALINE™ 610 is the same basic instrument as the Model 600 except it can be set up for either "YT" or "XY" recording. In the "XY" mode, the chart position and speed ("X" axis) are controlled by the input to Channel 1 through an A/D converter; Channels 2 through 6 drive pens along the "Y" axis. The Model 610 is switch convertible to a 1 to 6 channel "YT" mode recorder. In the "YT" mode, Channels 1 through 6 drive pens along the "Y" axis and the chart speed ("T") is crystal-controlled as in the Model 600.

Temperature Module Features

- **0.5% Accuracy**
- **Calibrated Zero Offsets**
- **Linearized Temperature Output (1 mV per °C)**
- **Fixed and Variable Spans**
- **0 to 100% Analog Output**
- **Switchable Cold Junction Compensation**
- **Thermocouples Types J, K, T, S, and B**
- **Platinum RTD's (α = 0.00385)**

Temperature Measurement Modules for Every Application

All temperature measurement modules have full linearization ove the complete operating range of th sensor. Through the use of only pr cision and high quality componen temperature accuracies as high as 0.5% are achieved. All the temper ture modules have as standard fea tures calibrated and variable span controls and calibrated zero offse With the combination of these cor trols, limitless spans correspondin to full scale deflections can be set to adapt the OMEGALINE™ 600 to virtually any temperature measurement application.

Using a fixed span and zero offset, full scale spans such as 500 °C to 600 °C can be set. For the more specialized temperature measurement problem, the variable span feature can be used. This feature expands the scale by i creasing amplifier sensitivity up to 2½ times. Full scale spans such a 500 °C to 540 °C, or even intermedi ate values of 515 °C to 555 °C are easily set.

600
OMEGA
REC CAL ON
COMP
VAR OFF
300 200 °C
150
100
50
0
-50
SHIFT
TYPE T Cu/Cu-Ni
°C
500
200
100
50
SPAN
max 42V

Temperature Recorders
OMEGALINE™ 600/610

In addition to both span and zero offset controls, every temperature module has a scaled linearized output of either 1 mV per °C or 10 mV per °C which can convert a digital multimeter into a digital thermometer. Other standard features include a linear output of 0 to 1 V which corresponds to 0 to 100% pen deflection, and switchable cold junction compensation (referenced to 0 °C) which allows differential temperature measurements as well as the use of remote cold junction compensators (such as OMEGA ENGINEERING's CJ or MCJ) so that inexpensive copper wire may be used to connect to the recorder where remote thermocouple locations are involved.

Instrument-Grade Voltage and Current Modules

- **Seven Modules Cover Complete Range**
  50 mV to 200 V dc
  10 mV to 20 V ac/dc
  1 mA to 2A ac/dc
  0.25 to 2 Decade Log
- **Electronic Event Marker**
- **Zero Offset ± 100% to 600%**
- **0 to 1 V Analog Output**
- **Fixed and Variable Gain**

The voltage and current modules are designed for general laboratory testing and R&D where high accuracy and versatility in measurement are required. A wide selection of features and ranges allows maximum versatility when designing your measurement system. All modules are fully interchangeable with any other module; temperature, voltage, or current.

There is one fixed range module (702) which has 11 voltage and 5 current ranges internally plug selectable for tamper-proof requirements and 6 multirange modules with up to 44 switch selectable ranges. Standard features on all multirange modules include electronic event marker, fixed and variable range, ± 100% zero offset, front panel zero switch, and a 0 to 1 volt analog output corresponding to 0 to 100% pen deflection. Standard features on selected modules include 5 x 100% calibrated zero offset, 6 x 100% automatic or manual zero offset, 0.3% accuracy, and ranges from 50 microvolts dc full scale.

Technical Data

Basic Instrument
YT-RECORDING
(Common data for OMEGALINE™ **600 and 610)**

Number of channels: 1—2—3—4—5—6
Recording width: 250 mm
Scale: 0 to 100 linear
Dead band: 0.15%
Repeatability: 0.15%
Linearity: 0.1%
Response Time: 0.3 sec.
Overshoot: max. 0.6%
Slewing Speed: max. 100 cm/sec
Frequency response: 2 Hz
Recording media: Ink pen, same type for all channels, permanently refillable, length of trace per filling approx. 1500 m. Interchangeable capillary or felt tips or disposable felt pens. Various ink colors for identification of channel. Time shift approx. 2.5 mm per channel.
Chart paper: DIN chart strips, linear, 270 mm wide, 32 m long; roll charts or folding paper (folding width 75 mm).
Chart drive mechanism: Vertical basic position or 45° tilted. Take-up device for roll charts, pick-up bin for folding paper or free chart run-out.
Chart drive: Drive by means of quartz controlled stepper motor with 128 steps/cm. Time keeping accuracy 30 ppm at 25 °C, 70 ppm at − 10 to + 50 °C.
12 chart speeds switch selected
1—2—3—6—12—30 cm/h
1—3—6—12—30—60 cm/min
Chart positioning, forward and reverse, by means of switch and progressive motor control.
Additional functions by means of TTL (open collector), or CMOS signal, or switch:
Preset speed: Any of the 12 chart speeds, internally plug-selected, actuated by means of external signal.
Pulse: Control of the chart advance by means of external pulses.
Stop: Chart advance stopped by external signal.
Power supply: 110—220—240 V ± 10% 50/60 Hz
Safety: Protection class 1 with earth conductor, acc. to VDE 0411
Insulation test: Power and measuring section to case (earth):
Voltage: 1.5 kV
Fuses: Medium time lag; 50 x 20 mm
OMEGALINE™ 600 110 V M2E 200 V M1C
OMEGALINE™ 610 100 V M4E 220 V M2E
Power consumption: Basic instrument approx. 15 VA, additional 8 VA per channel (with all options not exceeding a total of 100 VA)
Dimensions: H: 10.5″ (266 mm) x W: 17.5″ (444 mm) x D: 13.6″ (346 mm)
Weight: Fitted complete with 2 channels: 31.5 lb (14.3 kg)
4 channels: 35.2 lb (16.0 kg)
6 channels: 39 lb (17.7 kg)

XY-RECORDING

(for OMEGALINE™ 610 special technical data for the X axis)

The advance of the chart paper in the X coordinate is effected by a digital servo system with dc motor according to the measured quantity applied to the input of channel 1.

Number of channels: Channel 1: X recording:
Channels 2—3—4—5—6: Y-recording
Recording length: 250 mm (290 mm with overrange of ± 8%)
Dead band: 0.3%
Repeatability: 0.25%
Linearity: 0.1%
Response time: 0.45 sec
Overshoot: max. 0.6%
Slewing speed: max. 65 cm/sec
Frequency response: 1.3 Hz
Chart drive: Free chart run-out for XY recording
Mechanism chart advance: 300 mm (can be internally altered to 180 or 60 mm) by means of format switch or external TTL (open collector), or CMOS signal, or switch.
Paper positioning: Continuous positioning of the chart paper over the whole chart length, with switch for progressive forward and reverse run, possible when zero switch is depressed. The positioning of the paper proceeds independently of the electrical zero setting on the measuring unit of channel 1.
Operating mode: XY recording can be switched over by a switch to YT recording.

In case of YT recording, the switch selected chart speeds can be additionally varied by the factor x2 or x4 by means of internal plugs.

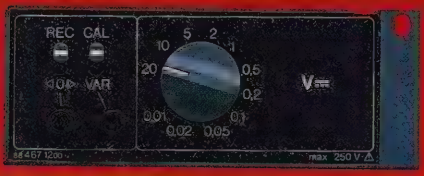
Temperature Recorders
OMEGALINE™ 600/610
Voltage and Current Modules

REC
10 V
88 467020
max 250 V

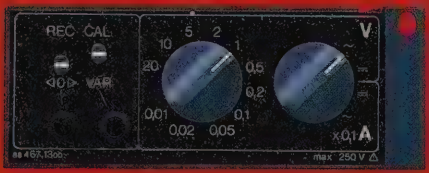
Module 702—Tamper resistant for applications where setting will not normally have to change. 16 Ranges internally selectable.
mV: 10, 20, 50, 100, 200, 500
V: 1, 2, 5, 10, 20
mA: 1, 2, 5, 10, 20
Accuracy: 0.3% FS or 5 μV, greater of
Zero setting: ± 100%
Monitor output: + 1V = 100% deflection (into 10 k Ω or greater)

REC
CAL
VAR
mV
V
x100%
88 467 1100
max 250 V

Module 711—Broad range, dc voltage. 18 ranges 0.5 mV to 200 V dc, calibrated zero offset 5 x 100%, manual.
Accuracy: 0.3% FS or 5 μV, greater of
Variable gain: 2.5 x calibrated value, continuous for each range
Zero setting: ± 100%
Monitor output: + 1V = 100% deflection (into 10 k Ω or greater)
Input protection: ranges 0.5 mV to 200 mV—100V, 0.5 V to 200V—250V
Calibrated zero offset: 5 x 100%, manual. Accuracy ± 0.2%
Input impedance: Ranges 0.5 mV to 200 mV—1000 M Ω, 0.5V to 200V—1 M Ω
Source impedance: 1 k Ω ref, max 10 k Ω
ac CMRR: Ranges 0.5 mV to 200 mV—150 dB; 0.5 V to 200V—90 dB
dc CMRR: 150 dB
Tempco: 0.1% per 10 °C or 0.2 μ V per °C, greater of
Event marking: TTL or CMOS actuation, 3mm positive pulse
Temperature range: – 10 °C to + 50 °C



Module 712—General purpose, dc voltage. 11 ranges 10 mV to 20 V
Accuracy: 0.3% FS or 5 μ V, greater of
Variable gain: 2.5 x calibrated value, continuous for each range
Zero setting: ± 100%
Monitor output: + 1 V = 100% deflection (into 10 k Ω or greater)
Input protection: Ranges 10 mV to 2V — 100 V, 5 V to 20 V — 250 V
Input impedance: Ranges 10 mV to 20 V —1 MΩ
Source impedance: 1 k Ω ref, max 10 k Ω
ac CMRR: 120 dB
dc CMRR: 120 dB
Tempco: 0.2% per 10 °C or 10 μ V per °C, greater of
Event marking: TTL or CMOS actuation, 3mm positive pulse
Temperature range: – 10 °C to + 50 °C



Module 713—Broad range, ac/dc voltage and current, 44 ranges 10 mV to 20 V, 1 mA to 2A
Accuracy: 0.3% of FS for mV, V dc; 1% of FS for mA, A dc; 1.5% of FS for mV, V (ac, 40 Hz to 10 kHz); 2% of FS for mA, A (ac 40 Hz to 1 kHz)
Variable gain: 2.5 x calibrated value, continuous for each range
Zero setting: ± 100%
Monitor output: + 1V = 100% deflection (into 10 k Ω or greater)
Input protection: Range 1 mA to 2A; protected by 2A fuse
Input impedance: Ranges 1 mA to 20 mA—10 Ω, 50 mA to 200 mA—1 Ω, 0.5 A to 2 A— 0.1 Ω
Source impedance: 1 k Ω ref, max 10 k Ω
ac CMRR: 120 dB
dc CMRR: 120 dB
Tempco: 0.2% per 10 °C or 10 μV per °C, greater of
Event marking: TTL or CMOS actuation, 3mm positive pulse
Temperature range: – 10 °C to + 50 °C

REC
CAL
VAR
mV
V
x100%
88 467 1400
max 250 V

Module 714—18 ranges, 50 μ V to 20 Vdc, calibrated zero offset 6 x 100%, manual or automatic
Accuracy: 0.5% FS or 1 μ V, greater of
Variable gain: 2.5 x calibrated value, continuous for each range
Zero setting: ± 100%
Monitor output: + 1V = 100% deflection (into 10 k Ω or greater)
Input protection: Ranges 0.05 mV to 20 mV—20 V, 0.05 V to 20 V—250 V
Calibrated zero offset: 5 x 100%, manual, Accuracy ± 0.2%
Input impedance: Ranges 0.05 mV to 20 mV—100 Ω, 0.05 V to 20 V—1 M Ω
Source impedance: 100 Ω ref, max 5 k Ω
ac CMRR: Ranges 0.05 mV to 20 Ω—150 dB, 0.05 V to 20 V—100 dB.
dc CMRR: 150 dB
Tempco: 0.2% per 10 °C or 0.5 μ V per °C, greater of
Event marking: TTL or CMOS actuation, 3mm positive pulse
Temperature range: – 10 °C to + 50 °C

REC
CAL
VAR
mV
V
x100%
AUTO
88 467 1500
max 250 V

Module 715—18 ranges, 0.05 mV to 200 Vdc, calibrated zero offset 6 x 100%, auto and manual
Accuracy: 0.3% FS or 5 μ V, greater of
Variable gain: 2.5 x calibrated value, continuous for each range
Zero setting: ± 100%
Monitor output: + 1 V = 100% deflection (into 10 k Ω or greater)
Input protection: Ranges 0.05 mV to 20 mV—100V, 0.05 V to 200 V—250V
Calibrated zero offset: 6 x 100%, manual and auto. Accuracy ± 0.2%
Input impedance: 0.05 mV to 200 mV—1000 M Ω, 0.05 V to 200 V—1 M Ω
Source impedance: 1 k Ω ref, max 10 k Ω
ac CMRR: Ranges 0.05 mV to 200 mV —150 dB, 150 dB, 0.5 to 200 V—90 dB.
dc CMRR: 150 dB
Tempco: 0.1% per 10 °C or 0.2 μ V per °C, greater of
Event marking: TTL or CMOS actuation, 3 mm positive pulse
Temperature range: – 10 °C to + 50 °C

Temperature Recorders
OMEGALINE™ 600/610

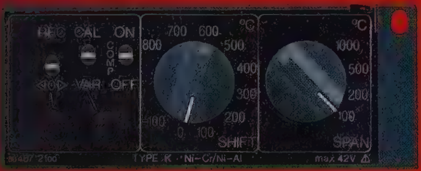
LIN
LOG
max 250V

Module 716—18 ranges, 0.5 mV to 200 Vdc, Log/Lin, 0.25 to 2 decades.
Accuracy: 0.3% FS or 5 µV, greater of
Variable gain: 2.5 x calibrated value, continuous for each range
Zero setting: ±100%
Monitor output: +1 V = 100% deflection (into 10 kΩ or greater)
Input protection: Ranges 0.05 mV to 200 mV—100V, 0.5 V to 200 V—250V
Input impedance: Ranges 0.5 mV to 200 mV—1000 MΩ, 0.5 V to 200 V—1 MΩ
Source impedance: 1 kΩ ref, max 10 kΩ
ac CMRR: Ranges 0.5 mV to 200 mV—150 dB, 150 dB, 0.5 V to 200 V—90 dB.
dc CMRR: 150 dB
Tempco: 0.1% per 10 °C or 0.2 µV per °C, greater of
Event marking: TTL or CMOS actuation, 3mm positive pulse
Temperature range: −10 °C to +50 °C

Temperature Modules

SHIFT
SPAN
TYPE J Fe/Cu-Ni
max 42V

Module 720—Type J (Fe/Cu-Ni)
Linearized range: −50 to 1100 °C
Accuracy span: 1.5 °C or 1% of scale length
Monitor outputs: A: 1 V per span; accuracy 1.5 °C or 1% of scale B: 1 mV per °C, accuracy 1.5 °C
Cold Junction Compensation: Built-in, switchable, 0 °C reference. Accuracy: 0.5 °C for 10 to 30 °C range 0.7 °C for 0 to 40 °C range
Input: Floating, asymmetric. Interruption of leads indicated by full scale deflection



Module 721—Type K (Ni-Cr/Ni-Al)
Linearized range: +100 to 1200 °C
Accuracy span: +1 °C or 0.5% of scale length
Monitor outputs: A: 1 V per span; accuracy 1 °C or 0.5% of scale
B: 1 mV per °C, accuracy 1 °C
Cold junction compensation: Built-in, switchable, 0 °C reference. Accuracy: 0.5 °C for 10 to 30 °C range 0.7 °C for 0 to 40 °C range
Input: Floating, asymmetric. Interruption of leads indicated by full scale deflection

SHIFT
SPAN
TYPE S Pt-10%Rh/Pt
max 42V

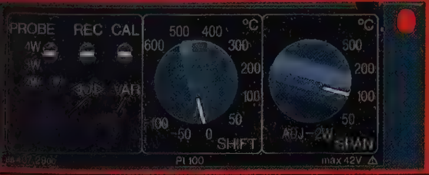
Module 722—Type S (Pt-10% Rh/Pt)
Linearized range: 0 to 1750 °C
Accuracy span: 1.5 °C or 1% of scale length
Monitor outputs: A: 1 V per span; accuracy 1.5 °C or 1% of scale
B: 1 mV per °C, accuracy 5 °C
Cold junction compensation: Built-in, switchable, 0 °C reference. Accuracy: 0.7 °C for 10 to 30 °C range 1.4 °C for 0 to 40 °C range
Input: Floating, asymmetric. Interruption of leads indicated by full scale deflection

SHIFT
SPAN
TYPE B Pt-30%Rh/Pt-6%Rh
max 42V

Module 723—Type B (Pt-30% Rh/Pt-6% Rh)
Linearized range: +500 to 1800ºC
Accuracy span: 1.5 °C or 1% of scale length
Monitor outputs: A: 1 V per span; accuracy 1.5 °C or 1% of scale
B: 1 mV per °C, accuracy 5 °C
Input: Floating, asymmetric. Interruption of leads indicated by full scale deflection

SHIFT
SPAN
TYPE T Cu/Cu-Ni
max 42V

Module 724—Type T (Cu/Cu-Ni)
Linearized range: −100 to 400 °C
Accuracy span: 1.5 °C or 1% of scale length
Monitor outputs: A: 1 V per span; accuracy 1.5 °C or 1% of scale
B: 1 mV per °C, accuracy 1.5 °C
Cold junction compensation: Built-in, switchable, 0 °C reference. Accuracy: 0.6 °C for 10 to 30 °C range 1.3 °C for 0 to 40 °C range
Input: Floating, asymmetric. Interruption of leads indicated by full scale deflection



Module 729—Type PT-100, Resistance Thermometer α = 0.00385
Linearized range: −100 to 850 °C
Accuracy span: 1.5 °C or 1% of scale length
Monitor outputs: A: 1 V per span; accuracy 1 °C or 0.5% of scale
B: 10 mV per °C, accuracy 1 °C
Input: 2-, 3-, and 4-wire connection by choice via 6-pin connector; lead resistance optional on 2-wire connection ⩾ 15 Ω

Common Specifications for Temperature Modules

Zero position: Continuous from 0 to +100%
Variable gain: 2.5 x calibrated value, continuous for each range
Source impedance: (for thermocouple models) Maximum 500 Ω
ac NMRR: 50 Hz upwards — 40 dB
ac CMRR: 120 dB
Tempco: 0.2 °C or 0.2% of scale per 10 °C, greater of
Operating temperature: 0 °C to 40 °C
Zero shift accuracy: 0.3% of nominal

Control System

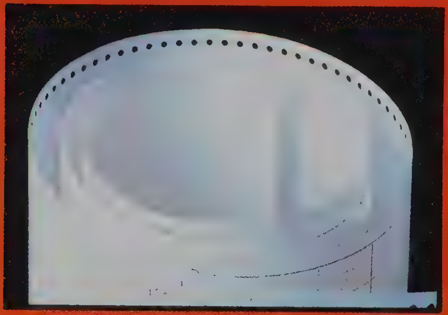
The controls are easily visible and accessible on the front panel. Their ergonomic design and arrangement makes them extremely precise and simple to use. Either roll or Z-fold paper can be used without the addition or removal of accessories. A take-up reel and dust-free hopper for the paper are standard. Another unique feature is that the pens are identical for each channel. The colors can be assigned freely to the required channel. They are also transparent so the fluid level and color are easily visible. A full pen lasts for about 1500 meters of writing between refills. Disposable felt pens are also available in a rainbow of colors, for those who prefer the convenience.

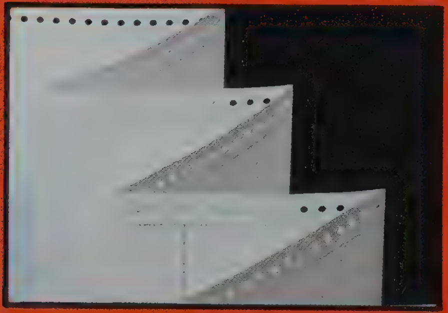
Recording System

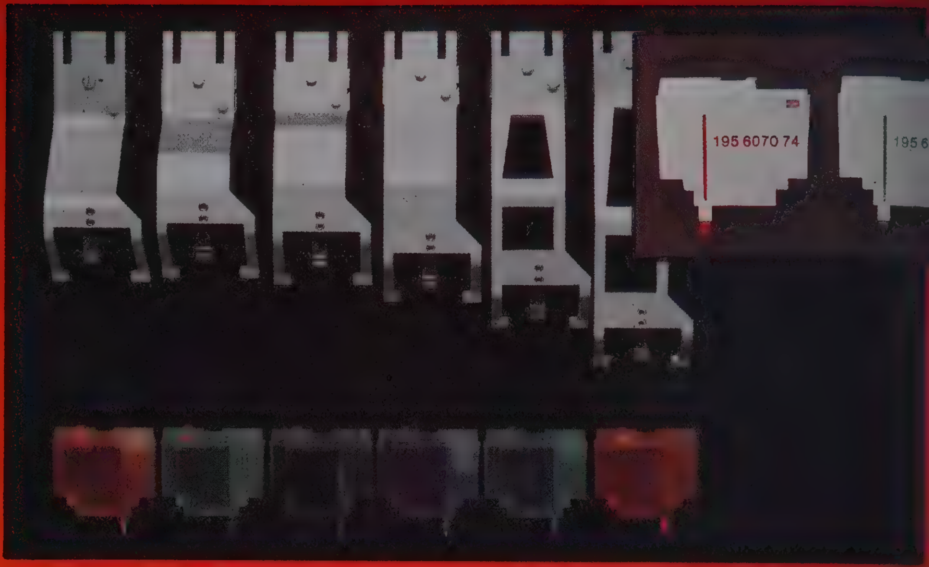
The length of the pen holding arm is the only component that varies between the different channels. The arms are strong yet lightweight and even the channel with the longest arm traces a precise continuous line following a step function. Every recorder is supplied with a complete writing accessory kit detailed in the chart under Writing Accessories.

Chart System

The recording platen has two recording positions. It can be either flush with the front of the instrument (vertical) or tilted at a 45-degree angle for easy notations on the chart paper. The system is designed to work with either roll or Z-fold paper which is either rolled or stacked in a convenient dustproof hopper. Either paper is 32 meters long and has a linear 0 to 100 grid with major divisions of 10.



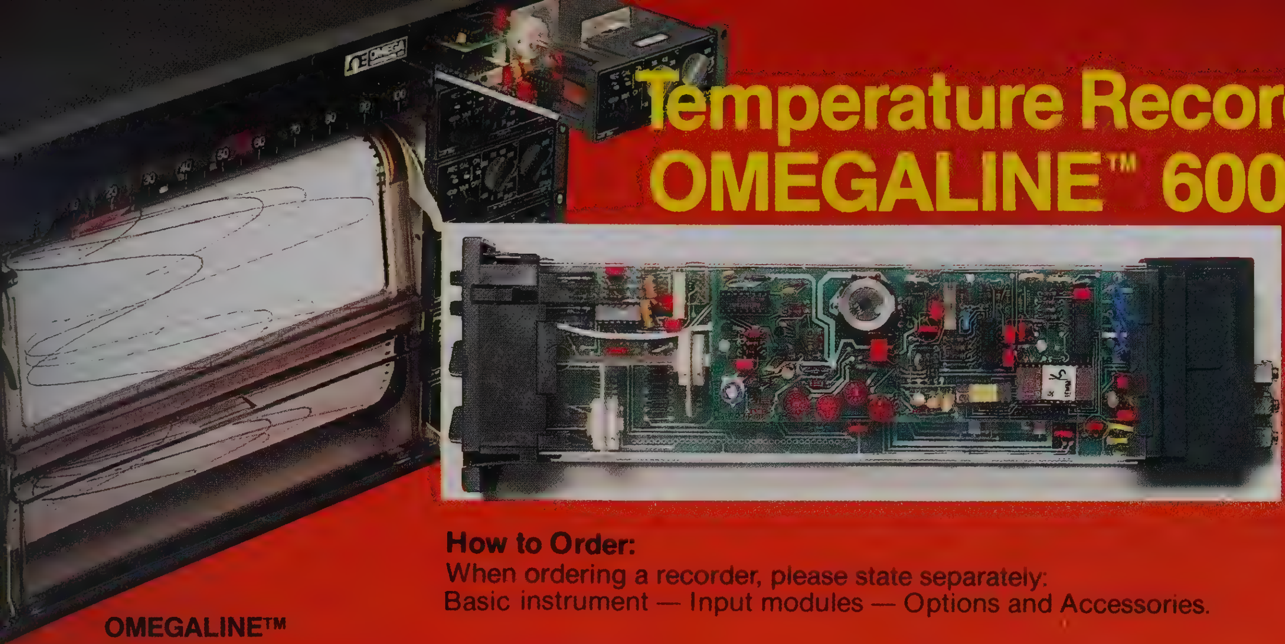




Writing Accessories		Cat. No.	Price
Ink pen for Channels 1-6 and event marker		SL-IP	$ 15.50
Set of capillary writing tips (6)		SL-CT	17.50
Set of felt-nylon writing tips (6)		SL-FT	17.50
Disposable felt pen for Channels 1-6 and event marker (pkg of 3)			
Channel coordination optional	Red	SL-100	12.00
	Blue	SL-101	12.00
	Green	SL-102	12.00
	Black	SL-103	12.00
	Brown	SL-104	12.00
	Purple	SL-105	12.00
Recording ink, quick drying, 20 cc bottle			
Channel coordination optional	Red	SL-200	10.00
	Blue	SL-201	10.00
	Green	SL-202	10.00
	Black	SL-203	10.00
	Brown	SL-204	10.00
	Purple	SL-205	10.00
Filling syringe		SL-SY	5.00
Capillary pen cleaner		SL-CL	8.00
Set of filling needles		SL-NE	8.00
Chart paper Roll chart, linear, 32 m long	1 roll	SL-RP-1	8.00
	10 rolls	SL-RP-10	65.00
	25 rolls	SL-RP-25	145.00
Z-fold pack, linear, 32 m long	1 pack	SL-ZP-1	10.00
	10 packs	SL-ZP-10	90.00
	25 packs	SL-ZP-25	220.00

Writing Accessory Kit Supplied with each instrument	OMEGALINE™ 600						OMEGALINE™ 610				
	01	02	03	04	05	06	02	03	04	05	06
Ink-pen	1	2	3	4	5	6	2	3	4	5	6
Set of capillary writing tips	1	2	3	4	5	6	2	3	4	5	6
Set of fiber writing tips	1	2	3	4	5	6	2	3	4	5	6
Recording ink—red	1	1	1	1	1	1	1	1	1	1	1
blue		1	1	1	1	1	1	1	1	1	1
green			1	1	1	1		1	1	1	1
black				1	1	1			1	1	1
brown					1	1				1	1
purple						1					1
Filling and cleaning syringe	1						1				
Cleaning needle (in vial)	5						5				
Screwdriver (Phillips)	1						1				
Spare fuses M 1 C (GMA-1)	2										
M 2 E (GMA-2)	2						2				
M 4 E (GMA-4)							2				
Chart paper roll (32 m long)	1						1				
Z-fold (32 m long)	1						1				
Instruction Manual	1						1				

Temperature Recorders
OMEGALINE™ 600/610



How to Order:
When ordering a recorder, please state separately:
Basic instrument — Input modules — Options and Accessories.

OMEGALINE™ BASIC INSTRUMENT | **INPUT MODULES** | **OPTIONS** | **PRICE**

Example: OMEGALINE™ 600 — 04 / 720 / 720 / 721 / 712 / 902 / 903 / 904

asic 4-channel YT Recorder	600-04	$3,590
ype J Module in Channel 1	720	690
ype J Module in Channel 2	720	690
ype K Module in Channel 3	721	690
1 Range mV Mod. in Cha. 4	712	275
en Event Marker	902	95
lectric Pen Lift	903	110
upply Print (1 Req.)	904	60
		Total $6,200

Basic Instrument

YT-OMEGALINE™ 600	**Price**
1 channel 600-01	$1,940
2 channels 600-02	2,490
3 channels 600-03	3,040
4 channels 600-04	3,590
5 channels 600-05	4,140
6 channels 600-06	4,690
XY-YT-OMEGALINE™ 610	
2 channels 610-02	3,890
3 channels 610-03	4,400
4 channels 610-04	4,990
5 channels 610-05	5,540
6 channels 610-06	6,090

Options	**Cat. No.**	**Price**
Rack-mounting frame assembly	900	$95
Rack-mounting with ocking front door	901	275
Event marking device (L.H.) Supply print 904 required	902	95
Electric pen lift Supply print 904 required	903	110
Supply print one item only per instrument)	904	60
Retransmitting output for Channel 2 (floating)	905	230
Min-Max. contacts for Channel 1 (electronic)	906	230
Front panel handles requires option 900)	907	45

INPUT MODULES

Single range units	**Cat. No.**	**Price**
1 range plug selectable 10, 20. 50, 100, 200, 500 mV dc; 1, 2, 5, 10, 20 V dc ; 1, 2, 5, 10, 20 mA dc	702	$220
Multirange units		
18 ranges 0.5 mV . . . 200 V dc Calibrated zero supression 5 x 100% manually, Event marking	711	420
11 ranges 10 mV . . . 20 V dc Event marking	712	275
44 ranges 10 mV . . . 20V ac/dc 1 mA . . . 2A ac/dc, Event marking	713	450
18 ranges 50 μ V 20V dc Calibrated zero supression 5 x 100% manually, Event marking	714	495
18 ranges 0.5 mV . . . 200 V dc Calibrated zero supression 6 x 100% automatic and manual, Event marking	715	675
18 ranges 0.5 mV . . . 200 V dc lin-log 0.25—0.5—1—2 decades, Event marking	716	545
Temperature measuring units		
Type J (Fe/Cu-Ni), span −50 to +1100 °C, 5 ranges 50/100/200/500/1000 °C, linear, Calibrated zero shift in 10 steps. Cold junction compensation switchable	720	690
Type K (Ni-Cr/Ni-Al), span −100 to +1200 °C, 4 ranges 100/200/500/1000 °C, linear, Calibrated zero shift in 10 steps. Cold junction compensation switchable	721	690
Type S (Pt-10% Rh/Pt), span 0 to +1750 °C, 2 ranges 500/1000 °C, linear, Calibrated zero shift in 4 steps, Cold junction compensation switchable	722	690
Type B (Pt-30% Rh/Pt-6% Rh), span +500 to +1800 °C, 2 ranges 500/1000 °C, linear, Calibrated zero shift in 3 steps	723	690
Type T (Cu/Cu-Ni), span −100 to +400 °C, 4 ranges 50/100/200/500 °C, linear, Calibrated zero shift in 8 steps, Cold junction compensation switchable	724	690
Pt 100, Span −100 to +850 °C, 4 ranges 50/100/200/500 °C, linear, Calibrated zero shift in 10 steps, 2, 3, & 4-wire RTD connections	729	580

Thermocouple to Analog Converter

Model
TAC-386

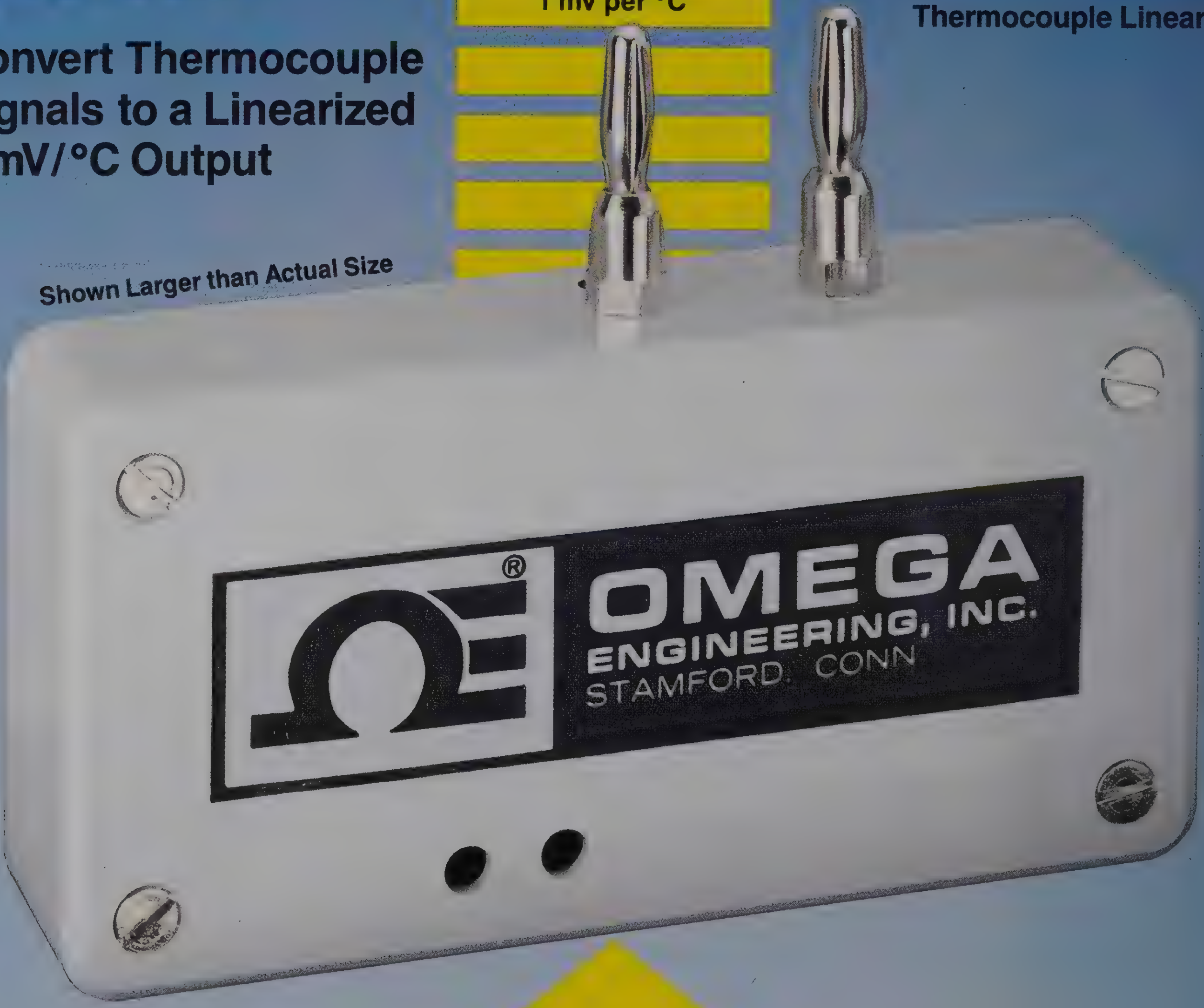
NEW!

OMEGA® Wite Box
Thermocouple Linearizer

Convert Thermocouple Signals to a Linearized 1 mV/°C Output

CONTINUOUS
ANALOG
VOLTAGE OUT

1 mV per °C



Shown Larger than Actual Size

Rugged—Heavy Duty Case

SIGNAL
IN

Any type J, K or T

Thermocouple

SPECIFICATIONS

Ranges: J −105° to 750°C
K −20° to 1200°C
T −86° to 350°C

Power: 9V Alkaline battery MN 160

Accuracy: ±4°C over entire range

Response Time: 2 to 3 seconds

Reference Junction Stability: .05°C/°C

Input Conn.: MPJ Miniature Panel Jack

Output Conn.: Std. Banana ¾″ spacing (19 mm)

Operating Temp.: 0° to 50°C

Storage Temp.: 0° to 65°C

Dimensions: W: 2½″ D: 3″ H: 2″

OFF-THE-SHELF DELIVERY

Any Calibration

$125 Battery Included

72
OMEGA
ENGINEERING, INC.
STAMFORD, CONN.
ON
R
Y

Model TAC-386

See Section M for Millivolt Recorders

Convert any Millivolt Recorder or Meter to Read Temperature

FEATURES

- High Accuracy ±4°C over entire range
- Linearized 1mV/°C Output
- Rugged—Completely Portable
- Long Battery Life
- Bi-polar Output
- Type J, K or T Thermocouple Input

Easy-to-Use

Set instrument to 200mV range for readings of less than 200°C. Set instrument to 2V range for readings above 200°C. Your multimeter will read out directly in temperature—just transpose mV or V to °C.

"Add temperature to your tool box."

The OMEGA TAC-386 can turn any chart recorder or analog or digital voltmeter into an accurate wide-range temperature measuring instrument. The TAC-386 is a universal thermocouple amplifier and linearizer which provides a precision 1mV/°C signal for the popular J, K, or T thermocouples. Cold junction compensation is standard.

See Sections A, B and D for thousands of Thermocouple Probes.

See Section C for a complete line of Hand Held Voltage and Temperature Instruments.

HOW TO ORDER

TAC-386-J–J thermocouple input	
TAC-386-K–K thermocouple input	
TAC-386-T–T thermocouple input	
Battery Included	**$125**

Recorders to Meet All Your Temperature and Millivolt Recording Needs

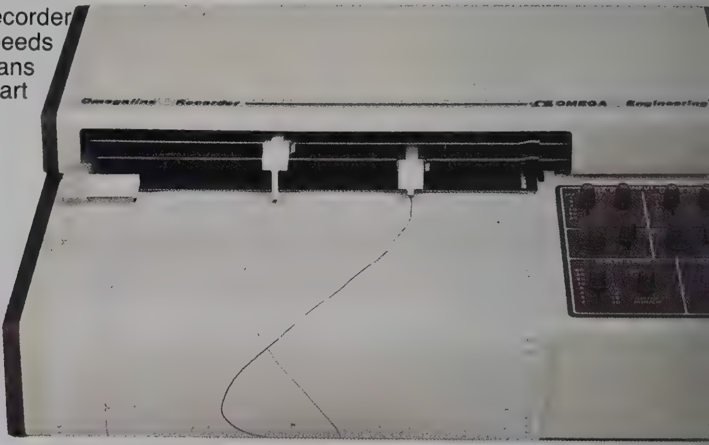
156 Single Channel **$695**
- Flat Bed Recorder
- 22 Chart Speeds
- 5 Input Spans 1 mV-10 Volt
- 125 mm Chart Width

ZERO
PUSH
INPUT
CHART
GND

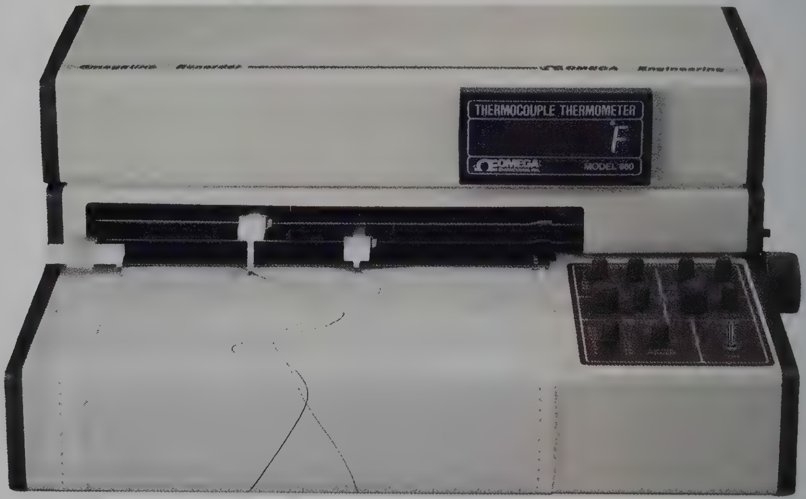
141 AC Powered **$755**
142 AC/DC Rechargeable **$895**
- Portable Recorder
- 10 Chart Speeds
- 5 Input Spans, 1 mV-10 Volt
- 100 mm Chart Width

NEW!

1201 Single Channel **$625**
1202 Dual Channel **$995**
- Flat Bed Recorder
- 16 Chart Speeds
- 12 Input Spans
- 200 mm Chart Width


Omegaline Recorder
OMEGA Engineering

$595
143 Recording Module
- For Custom Applications
- Multi Speed
- Multi Input Spans
- 100 mm Chart Width


Omegaline Recorder
OMEGA Engineering
THERMOCOUPLE THERMOMETER
°F
OMEGA
MODEL 660

NEW! Series 1200 Recorders with Thermocouple Inputs

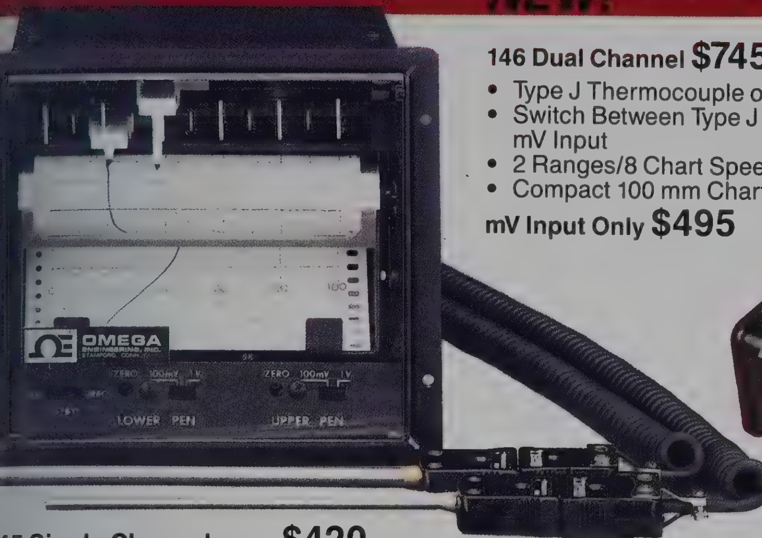
Model 1202-660-1 Shown $1495
Dual Channel Recorder Having One mV Channel and One Linearized Thermocouple Channel. See Page N-36 for Other Models.

NEW!

146 Dual Channel $745

- Type J Thermocouple or mV Input
- Switch Between Type J and mV Input
- 2 Ranges/8 Chart Speeds
- Compact 100 mm Chart Width

mV Input Only $495


OMEGA
ENGINEERING, INC.
STAMFORD, CONN.
ZERO 100mV 1V
ZERO 100mV 1V
LOWER PEN
UPPER PEN

45 Single Channel Type J Thermocouple or mV Input	**$420**
mV Input only	**$295**

NEW!

555 Single Channel	**$895**
585 Dual Channel	**$1,295**

- Flat Bed Recorder
- 22 Chart Speeds/Programmable
- 12 Input Spans 1 mV-5 Volt
- Servo Kill Feature

OMEGA
ENGINEERING, INC.

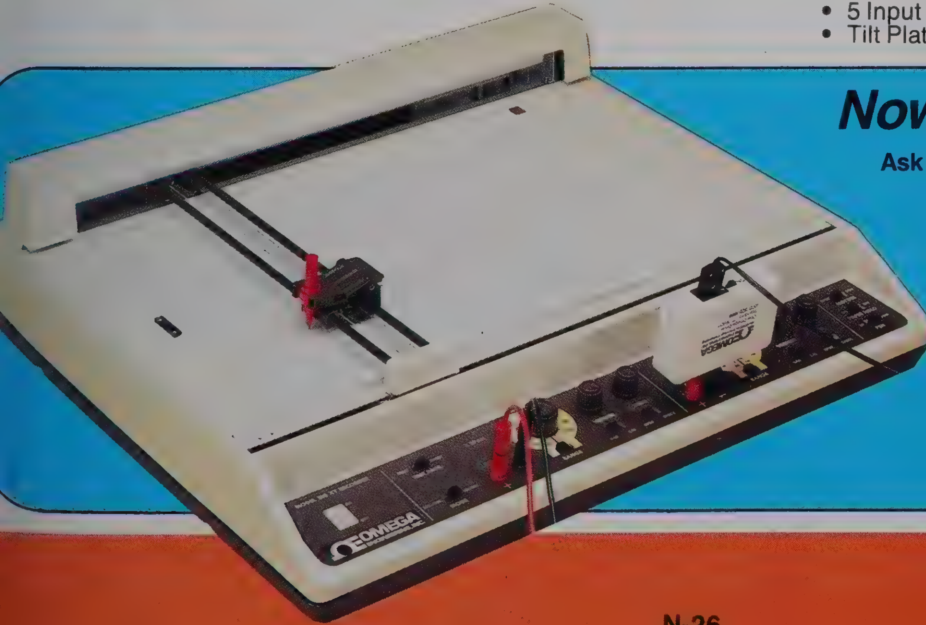
$1,850

595 Three Channel

- 22 Chart Speeds/Programmable
- 12 Input Spans 1 mV-5 Volt

456 Single Channel	**$995**
486 Dual Channel	**$1,295**

- Rack Mount Recorder
- 12 Chart Speeds
- 5 Input Spans 1 mV-10 Volt
- Tilt Platen Feature



Now Available!

Ask for Bulletin No.: P-83-31

Precision XY Recorder

- 11 mV Input Ranges
- 8 Timebase Ranges
- Up to 11 × 17 Paper

$1500

N

Strip Chart Recorders NEW!
With Thermocouple and Millivolt Inputs

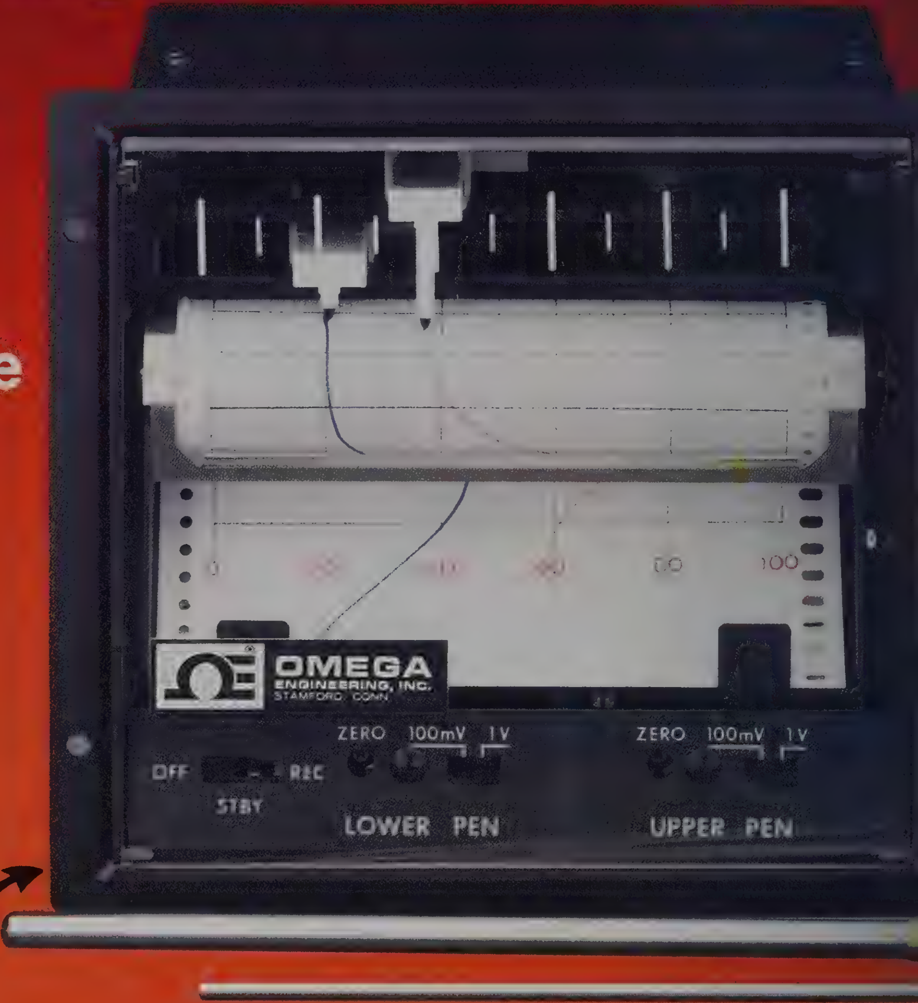
Rugged Metal Case for Panel or Bench Operation

- Compact 100 mm Chart Width
- Type J Thermocouple Input

4 Models Available

RD-145-mV One Channel, mV Input	$295
RD-145-J [*] One Channel, Switchable Thermocouple/mV Input	$420
RD-146-mV Dual Channel, mV inputs	$495
RD-146-J [*] Dual Channel, Switchable Thermocouple/mV Inputs	$745

**Specify °C or °F*



- Switch Between Thermocouple or Millivolt Input
- Set Thermocouple Zero without Signal Input
- 2 Temperature Ranges
- 2 Voltage Ranges
- 8 Chart Speeds

How to Order

1. Specify Model Number
   Model RD-145 single inpu
   Model RD-146 dual input
2. Specify Input Range JF, Jc, or mV
3. Select Accessories

Example:
Model RD-145-mV

Each unit comes complete with 1 pen per channel, 1 pack of paper, and an operator's manual.

Ranges

Range Code	All Models Dual Range	
	Low	High
JF	0° to 250°F 0 to 100 mV	0° to 1000°F 0 to 400 mV
JC	0° to 100°C 0 to 100 mV	0° to 500°C 0 to 500 mV
mV	0 to 100 mV	0 to 1 Volt

Accessories: *Keep extra pens and paper on hand.*

Chart Paper:	Z fold 8 meters long	No. 0100-0132	6 pack/$25
Disposable Pens:	Short nib (CH. 1)	Long nib (CH. 2)	
Blue	No. 0100-0105	No. 0100-0109	6 pack/$10.75
Red	No. 0100-0106	No. 0100-0110	6 pack/$10.75
Black	No. 0100-0107	No. 0100-0111	6 pack/$10.75
Green	No. 0100-0108	No. 0100-0112	6 pack/$10.75

Bezel Mount: RD-140-BM **$25** **Rack Mount:** RD-140-RM **$20**

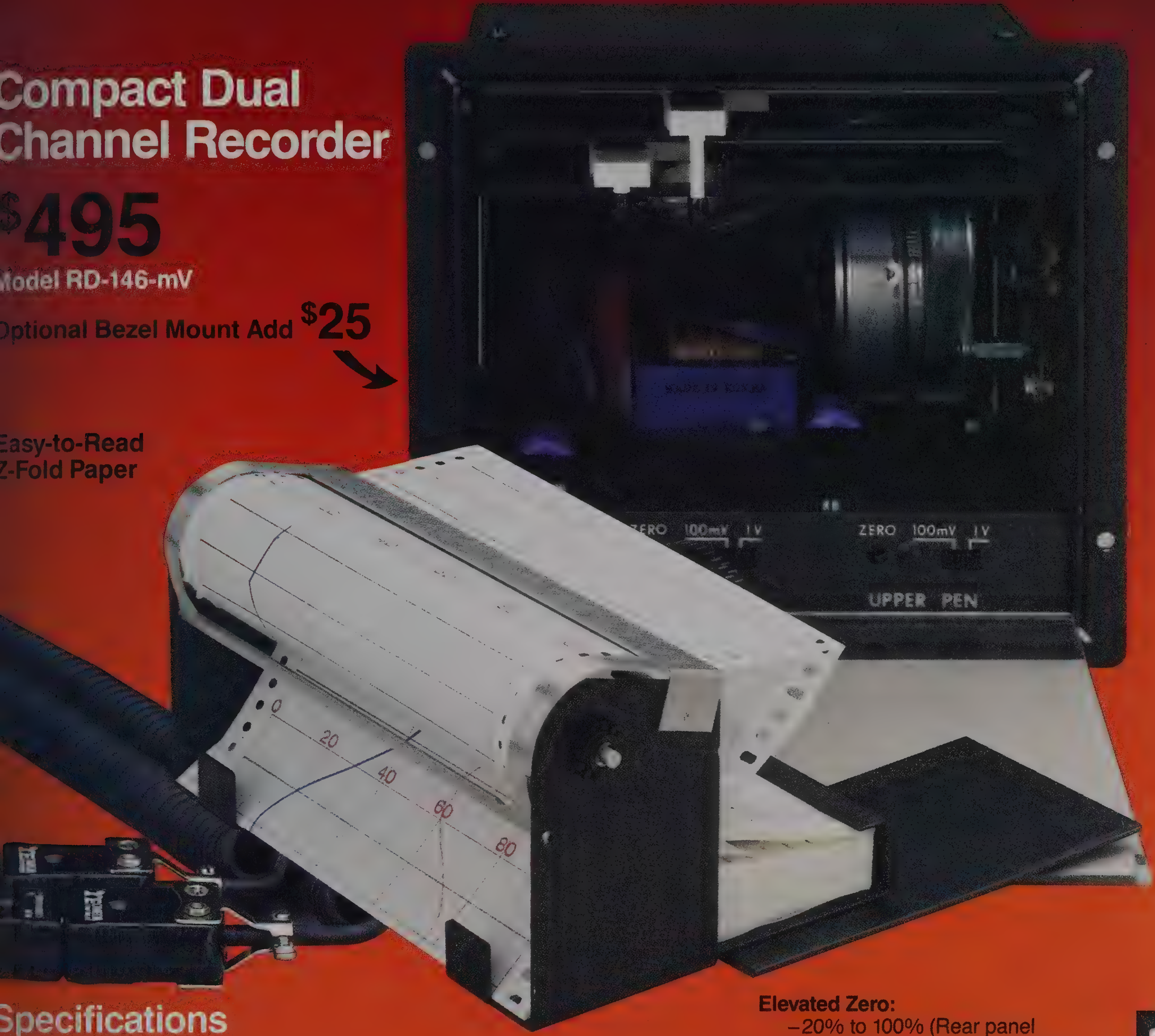
Compact Dual Channel Recorder

$495

odel RD-146-mV

Optional Bezel Mount Add $25

Easy-to-Read
Z-Fold Paper



Specifications

Cold Junction Compensation:
Temperature units "J" thermocouple only

ccuracy:
±1% Span. STD temperature units not linearized

hart Drive:
Synchronous motor

hart Paper:
100 mm writing width; 8 meters long; Fan fold @ 4 cm; olive color grid

hart Speeds:
By gear selection — .5, 1, 2, 4 cm/min or cm/hr. Gear sets supplied.

hannels/Pens:
1 or 2

vent Marker:
Override event std.

Input Impedance:
2 megohms typical

Source Impedance:
Up to 20 K ohms

Ranges (JC Unit):
0-100°C and 0-500°C. *Note:* With switch on mV, the mV ranges are 0-100 mV and 0-500 mV

Ranges (JF Unit):
0-250°F and 0-1000°F. *Note:* With switch on mV, the mV ranges are 0-100 mV and 0-400 mV.

Range (mV Unit):
0-100 mV and 0-1 Volt

Suppressed Zero:
−20% to 100% (Front panel access hole, mini blade)
0 to 500% (Rear panel access hole, lower temperature range only) e.g., JC unit can be set to read 500 to 600°C

Elevated Zero:
−20% to 100% (Rear panel access hole, lower temperature range only) e.g., JC unit can be set to read −100° to 0°C

Normal Mode Rejection:
16 dB @ 60 Hz

Panel Opening:
H: 5.12″ (130 mm) × W: 5.7″ (144 mm)

Pen Lift:
Manual

Power Requirements:
115 V ac ±10% 60 Hz
1 Pen—5.5 watts
2 Pens—7 watts

Response:
0.5 sec full scale

Dimensions:
H: 5.5″ (140 mm); W: 4.96″ (126 mm); D: 6.5″ (165 mm)

Mounting:
Optional—Bezel
Optional—Rack Mount

Strip Chart Recorders

Portable

Model 141

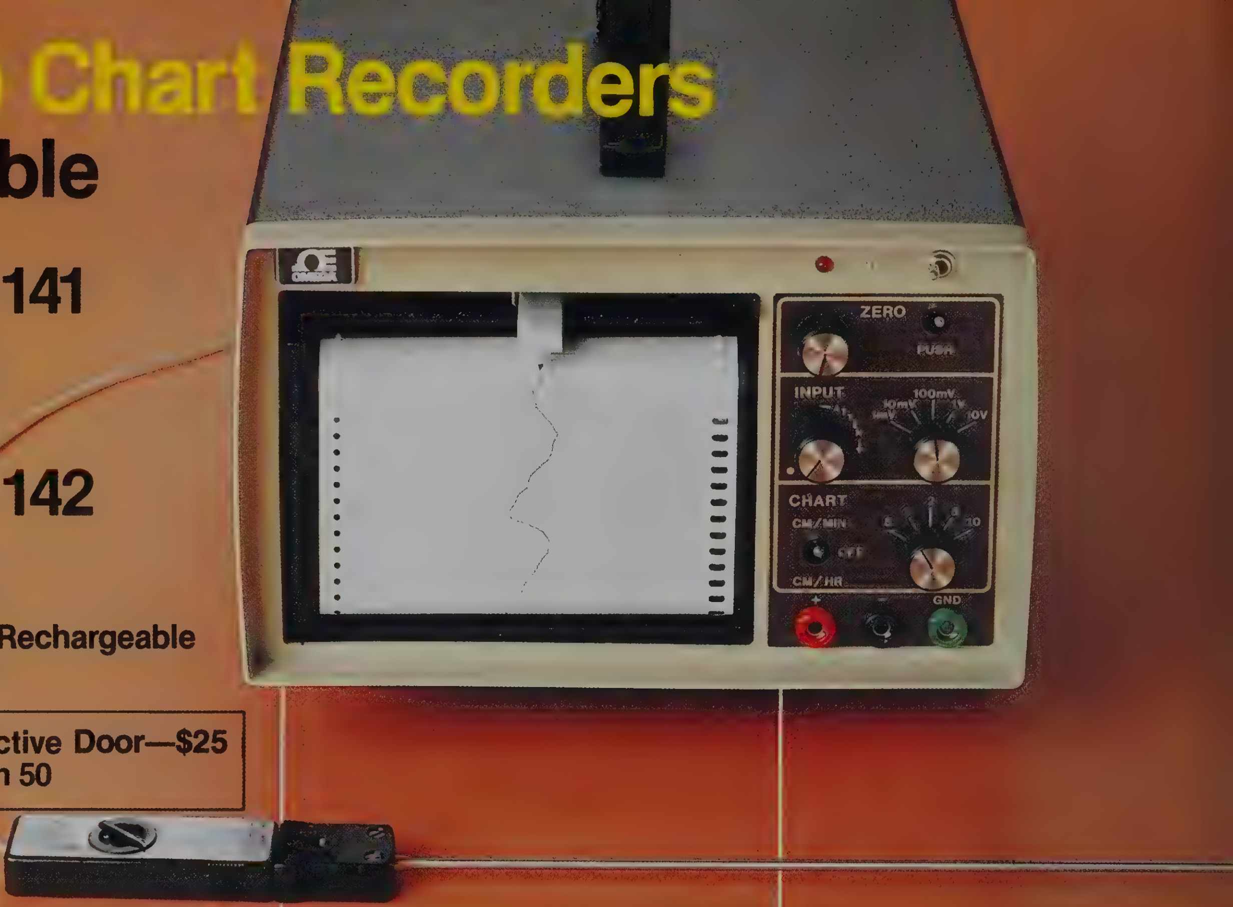
$755

Model 142

$895

with Built-in Rechargeable Battery Pack

NEW! Protective Door—$25
Order Option 50



The Model 141 is a small, portable ac powered recorder which offers multiple span input ranges from 1 mV through 10 volts with a variable attenuator to 100 volts. The chart drive has ten speeds ranging from 0.5 cm hour to 10 cm/minute. Using roll chart paper 30 meters long, tests can be run over a long period of time, and a permanent record is maintained.

This unit features a unique servo drive system that practically eliminates dead band, plus an electronic servo "shutdown" for off-scale protection.

The Model 142 is identical in appearance and specifications to the Model 141. However, this unit is powered by an internal battery pack. Many hours of recording can be done on a fully charged battery which is rechargeable by just plugging it into a wall receptacle, and up to 200 charges can be made on one battery.

Being battery operated and only eleven pounds light, it will be easy to carry this recorder into the field for necessary tests where ac power is not available.

Thermocouple probe and Electronic Ice Point extra.

Precision Design

- **100 mm Chart Width**
- **10 Chart Speeds**
- **5 Input Spans, 1 mV to 10 Volts**
- **100% Zero Suppression**
- **100% Full Scale Zero**
- **Model 142 Battery Operated**

General Specifications

Number of Channels: 1
Full Scale Span (Switch Selected): 1, 10, and 100 mV; 1 and 10 Volts with variable 10:1 attenuator to 100 Volts dc
Input Type: Single ended (floating, up to ± 100 V)
Input Impedance: 2.5 M Ω
Chart Width: 100 mm
Chart Speeds: 0.5, 1, 2, 5, 10 cm/minute and cm/hour
Writing Method: Disposable fiber-tipped pens
Accuracy: Overall limit of error < ± 0.5%
Response Time: <0.5 sec. full scale
Zero Adjust: Continuously adjustable from − 100% to + 100%
Power: Model 141-115/230 V ac Model 142- + 12 V dc battery, recharges on 115/230 V ac
Battery Life: (Model 142) 6 hours to over 1 week (dependent on chart speed and recording rate)
Weight: Model 141: 9.5 lbs. (4.3 kg) Model 142: 11 lbs. (5 kg)
Dimensions: H: 6.25" (158.8 mm) x W: 8.75" (222 mm) x D: 11.5" (292.1 mm)
Accessories Furnished: One disposable pen, one roll chart paper, one instruction manual. Model 142—one rechargeable battery (internal)
Works with Thermocouples! Use 1 or 10 mV range and a cold junction compensator or a digital instrument with analog output.

Options: Order options 31, 39, or 50. See Page **N-39**

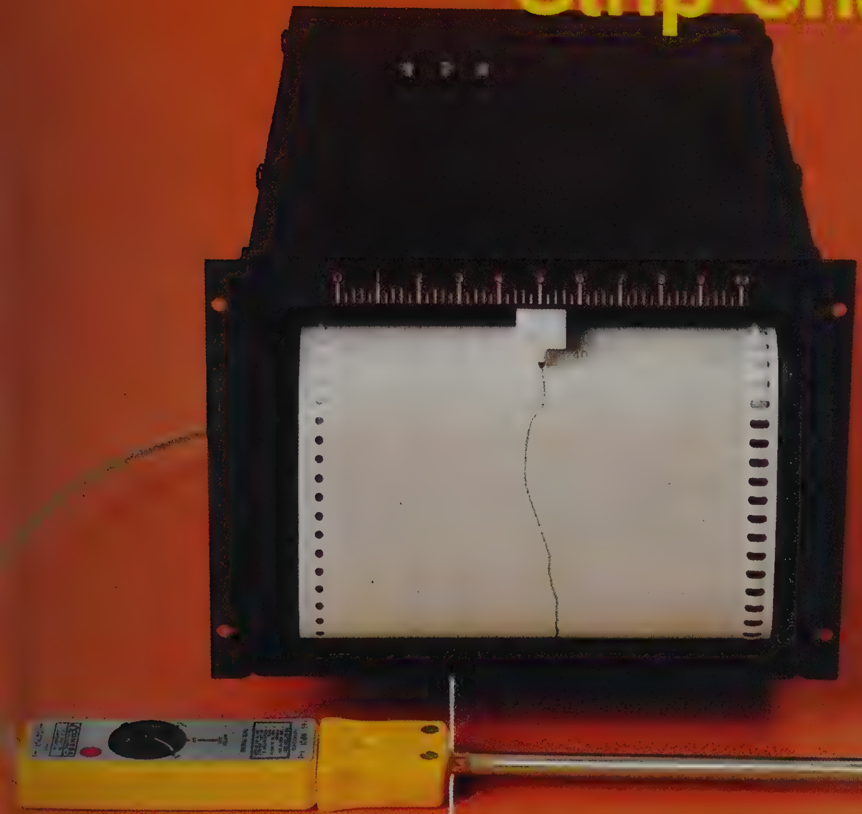
How to Order:

Specify **Model 141 $695**
Specify **Model 142**
Battery operated **$875**
Specify pens, paper, probes, or options by number.
Consult Sales Department for **Ice Point References, Thermocouples** and **Thermocouple Wire.**

Accessories: *Keep extra pens and paper on hand.*

Chart Paper:	0-100 grid, 30 meters long	No. 0100-0011	6 rolls/$36
Z-Fold Paper:	100 mm Wide	No. 0100-0028	1 pkg/$10
Disposable Pens:	Blue	No. 0100-0105	6 pack/$10.75
	Red	No. 0100-0106	6 pack/$10.75
	Black	No. 0100-0107	6 pack/$10.75
	Green	No. 0100-0108	6 pack/$10.75
Dust Cover:	Clear	No. 0100-0203	each/$7

Strip Chart Recorders



Compact Recording Module

Model 143

$595

NEW! Protective Door—$35
Order option 50

he Model 143 is a single channel ecorder designed as a bench top or anel mounting recording module. ll essential elements to assure recise and reliable charting are ompactly mounted in a lightweight ain frame which also serves as he enclosure.

unique low power consumption ulse servo system is used to drive he pen. The characteristics of this ype of system practically eliminate ead band and allow very stable ecording. Input ranges are easily hanged by adjustment of internal mpers.

stepper motor is the drive force r the chart drive system. A simple ternal jumper adjustment will eld 12 different speeds.

put connections, power on/off witch, power cord, and fusing are cated on the rear panel. Top panel removable for easy access to hart speed, input range, 115/230 V c, and zero jumper adjustments. ottom panel has rubber feet for ench placement or brackets may e added to the side panels for rack r cabinet mounting. For the most emanding applications in dustrial process monitoring, nvironmental studies, and energy onsumption tests.

hermocouple Probe and lectronic Ice Point extra. See ections A and K.

Precision Design

- **100 mm Chart Width**
- **12 Selectable Chart Speeds**
- **6 Selectable Input Ranges**
- **100% Full Scale Zero**
- **Voltage and Current Input**

General Specifications

Number of Channels: 1
Chart Drive: Stepper Motor
Chart Speeds: 12 manually selected speeds: 0.25, 0.5, 1, 2, 4, 8 cm/min; 1, 2, 4, 8, 16, 32 cm/hr
Chart Speed Accuracy: <0.2% error
Chart Speed Temperature Drift: <0.01%/°C
Servo: Pulse servo system
Input Range: 1, 10, and 100 mV — manually selected 1, 10, and 100 mA — manually selected
Accuracy: < ±0.5% overall limit of error on voltage ranges < ±1% overall limit of error on current ranges
Input Impedance: >20 M Ω (voltage ranges)
Type of Input: Single ended, floating
Response Time: 0.5 seconds, full scale
Source Impedance: >50 k Ω will degrade specifications.
Zero Range: Continuously adjustable from −100% to +100%
Power: 115/230 V ac, 50, 60, 400 Hz — manually selected
Writing Method: Disposable fiber-tipped pens
Weight: 4.25 lbs (1.91 kg)
Dimensions: H: 4.56″ (115.8 mm) x W: 5.72″ (145.3 mm) x D: 8.12″ (206.3 mm)
Works with Thermocouples! Use 1 or 10 mV range and a cold junction compensator or a digital instrument with analog output.

Options: Order options 31, 39, or 50. See Page **N-31.**

How to Order:

Specify **Model 143 $595**
Specify pens, paper, probes, or options by number.

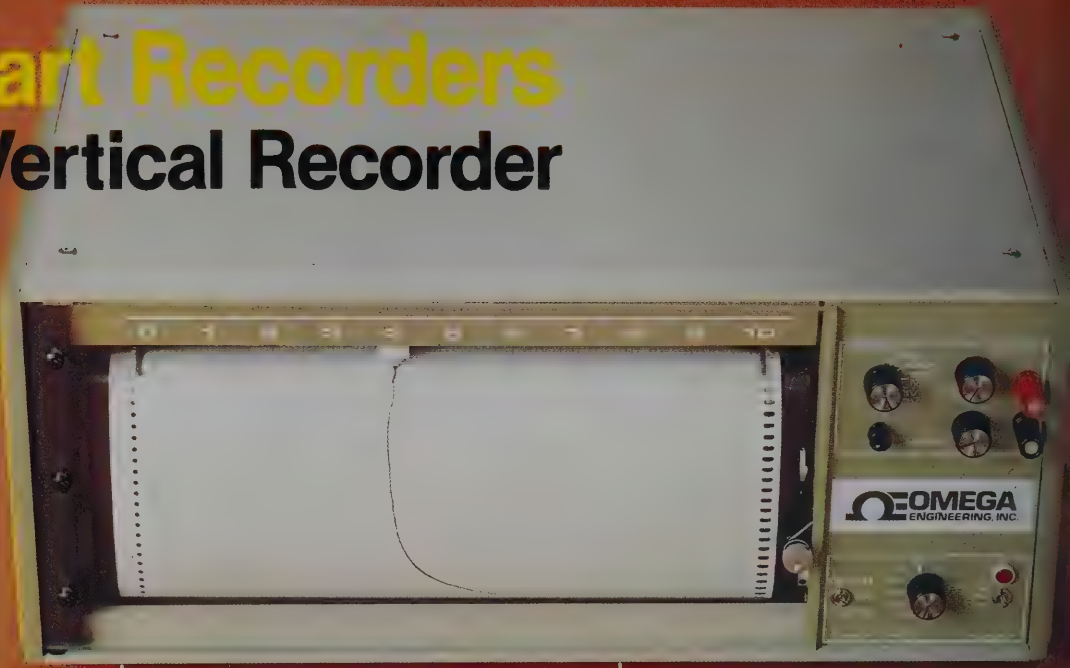
Accessories: *Keep extra pens and paper on hand.*

Chart Paper:	0-100 grid, 30 meters long	No. 0100-0011	6 rolls/$33
Z-Fold Paper:	100 mm Wide	No. 0100-0028	1 pkg/$10
Disposable Pens:	Blue	No. 0100-0105	6 pack/$10
	Red	No. 0100-0106	6 pack/$10
	Black	No. 0100-0107	6 pack/$10
	Green	No. 0100-0108	6 pack/$10
Dust Cover:	Clear	No. 0100-0203	each/$10
Mounting Brackets:	Specify at time of order.		N/C

Ice Point References — See Section K
Thermocouples — See Section A
Thermocouple Wire — See Section H

Strip Chart Recorders

One Pen Vertical Recorder



Model 456

$995

For more information on the OMEGA Thermocouple to Analog Converter (TAC), see page N-23.

The Model 456 single pen recorder is the new leader in the wide chart, cabinet/rack recorder field. Proven, innovative, modular electronic design has been combined with sound industrial mechanical operation to provide low cost, lightweight and simple long-term permanent recording.

As a practical vertical package, the recorder can be used in a rack-mount application (mounting hardware is standard) or as a bench-type model. Either way, information is easily seen on the 250 mm chart paper. The control panel is of such a design that inputs and controls are right up front. There are also terminals located on the rear for input signals and options that may be ordered.

Other standard features include: Electric pen lift, 12 speed chart drive, chart take-up, and multirange inputs from 1 mV to 100 volts. The use of disposable nylon-tipped pens eliminates the mess involved with capillary writing systems. Specifications include 0.5 second full scale response time and overload protection so that up to ±100 V dc can be applied without damage to the instrument. A clear Plexiglas door provides visibility to the entire chart work area.

Thermocouple and Ice Point extra.

Precision Design

- **Multiple Chart Speeds**
- **Multiple Spans From 1mV**
- **250 mm Chart Width**
- **Rack or Bench Mount**
- **Protective Door**

General Specifications

Number of Channels: 1
Full Scale Spans: 1, 10, and 100 mV; 1 and 10 Volts plus variable 10:1 attenuator to 100 Volts dc
Input Type: Floating (± 100 Volts single ended)
Input Impedance: 10 M Ω minimum in 1 and 10 mV calibrated positions. 2.5 M Ω minimum in 100 mV, 1 and 10 V calibrated positions. 25 k Ω minimum in variable attenuator position.
Chart Width: 250 mm, 0-100 divisions
Chart Speeds: 12 speed. Metric: 0.5, 1, 2, 5, 10, 20 cm/min and cm/hr
Writing Method: Disposable fiber-tipped pen
Accuracy: Overall limit of error < ±0.5%
Response Time: 50 cm/sec., with source impedance 20 k Ω
Zero Adjust: Continuously adjustable from −100 to +100%
Pen Lift: Electrical
Power: 115/230 Vac, 50/60 Hz, 15 Watt
Dimensions: H: 7.5″ (190.5 mm) x W: 17.75″ (451 mm) x D: 12″ (305 mm)
Weight: 20.5 lbs. (9.3 kg)
Accessories Furnished: One pen, one roll chart paper, and one instruction manual
Special Features: Remote chart ON/OFF and remote pen lift contacts are standard on rear terminal. Override event marker is also standard.

Options: Order options 13, or 20. See Page **N-39**

How to Order:

Specify **Model 456 $995**
Select Options: See page **N-39**
Specify pens, paper, probes, or options by number.
Consult Sales Department for **Ice Point References, Thermocouples and Thermocouple Wire.**

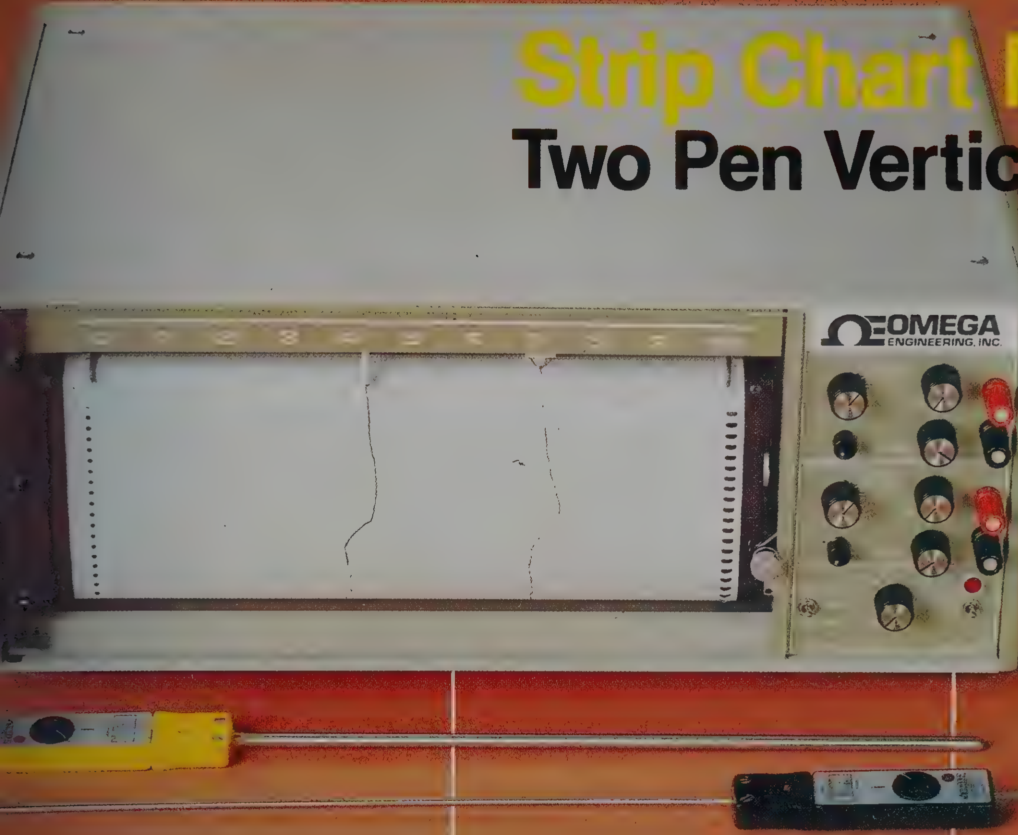
Accessories: *Keep extra pens and paper on hand.*

Chart Paper:	0-100 grid, 30 meters long	No. 0100-0025	6 rolls/$36
Disposable Pens:	Blue	No. 0100-0105	6 pack/$10.75
	Red	No. 0100-0106	6 pack/$10.75
	Black	No. 0100-0107	6 pack/$10.75
	Green	No. 0100-0108	6 pack/$10.75

Works with Thermocouples! Use 1 or 10 mV range and a cold junction compensator or a digital instrument with analog output.

Strip Chart Recorders

Two Pen Vertical Recorder



Model 486

$1,295

he **Model 486** is the "best buy" in he dual pen, cabinet/rack recorder eld. Proven, innovative, modular lectronic design has been comined with solid industrial mechanial operation to provide low-cost, ghtweight, and simple long-term ermanent recording.

s a practical vertical package, the ecorder can be used in a racknount application (mounting hardvare is standard) or as a bench-type nodel. Either way, information is asily seen on the 250 mm chart aper. The control panel is of such a esign that inputs and controls are ght up front. There are also termials located on the rear for input ignals and options that may be rdered.

ther standard features include: lectric pen lift, 12-speed chart rive, chart take-up, and multirange nputs from 1 mV to 100 volts with ariable attenuator. The use of disosable nylon-tipped pens elininates the mess involved with apillary writing systems. Specificaons include 0.5 second full scale esponse time and overload protecon so that up to ± 100 V dc can be pplied without damage to the nstrument. A clear Plexiglas door rovides visibility to the entire chart vork area.

hermocouple and Ice Point extra.

Precision Design

- **Dual Channel**
- **Multiple Chart Speeds**
- **Multiple Spans from 1 mV**
- **250 mm Chart Width**
- **Rack or Bench Mount**
- **Protective Door**

General Specifications

Number of Channels: 2

Full Scale Spans: 1, 10, and 100 mV; 1 and 10 Volts with variable 10:1 attenuator to 100 Volts DC

Input Type: Floating ± 100 volts (single ended)

Input Impedance: 10 M Ω minimum in 1 and 10 mV calibrated positions. 2.5 M Ω minimum in 100 mV, 1 Volt and 10 V calibrated positions. 25 k Ω minimum in variable attenuator position.

Chart Width: 250 mm, 0-100 divisions

Chart Speeds: 12 speed. Metric: 0.5, 1, 2, 5, 10, 20 cm/min and cm/hr

Writing Method: Disposable fiber-tipped pen.

Accuracy: Overall limit of error < ±0.5%

Response Time: Greater than 50 cm/sec., with source impedance less than 20 k Ω

Zero Adjust: Continuously adjustable from −100% to +100%

Pen Lift: Electrical

Power: 115/230 V ac, 50/60 Hz, 20 Watts

Dimensions: H: 7.5″ (190.5 mm) x W: 17.75″ (451 mm) x D: 12″ (305 mm)

Weight: 26 lbs. (11.8 kg)

Accessories Furnished: One short nib pen, one long nib pen, one roll chart paper, and one instruction manual

Special Features: Remote chart ON/OFF and remote pen lift contacts are standard on rear terminal. Override event marker is also standard on pen 1.

Options: Order options 13, 16, or 20. See Page **N-39**

How to Order:

Specify **Model 486 $1,295**
Select Options: See page **N-39**
Specify pens, paper, probes, or options by number.
Consult Sales Department for **Ice Point References, Thermocouples** and **Thermocouple Wire.**

Accessories: *Keep extra pens and paper on hand.*

Chart Paper:	0-100 grid, 30 meters long	No. 0100-0025	6 rolls/$36
Disposable Pens:	Short nib	Long nib	
Blue	No. 0100-0105	No. 0100-0109	6 pack/$10.75
Red	No. 0100-0106	No. 0100-0110	6 pack/$10.75
Black	No. 0100-0107	No. 0100-0111	6 pack/$10.75
Green	No. 0100-0108	No. 0100-0112	6 pack/$10.75

Works with Thermocouples! Use 1 or 10 mV range and a cold junction compensator or a digital instrument with analog output.

Strip Chart Recorders **NEW!**

Single or Dual Pen Flatbed Recorders

Compact 200 mm Chart

Model RD-1201

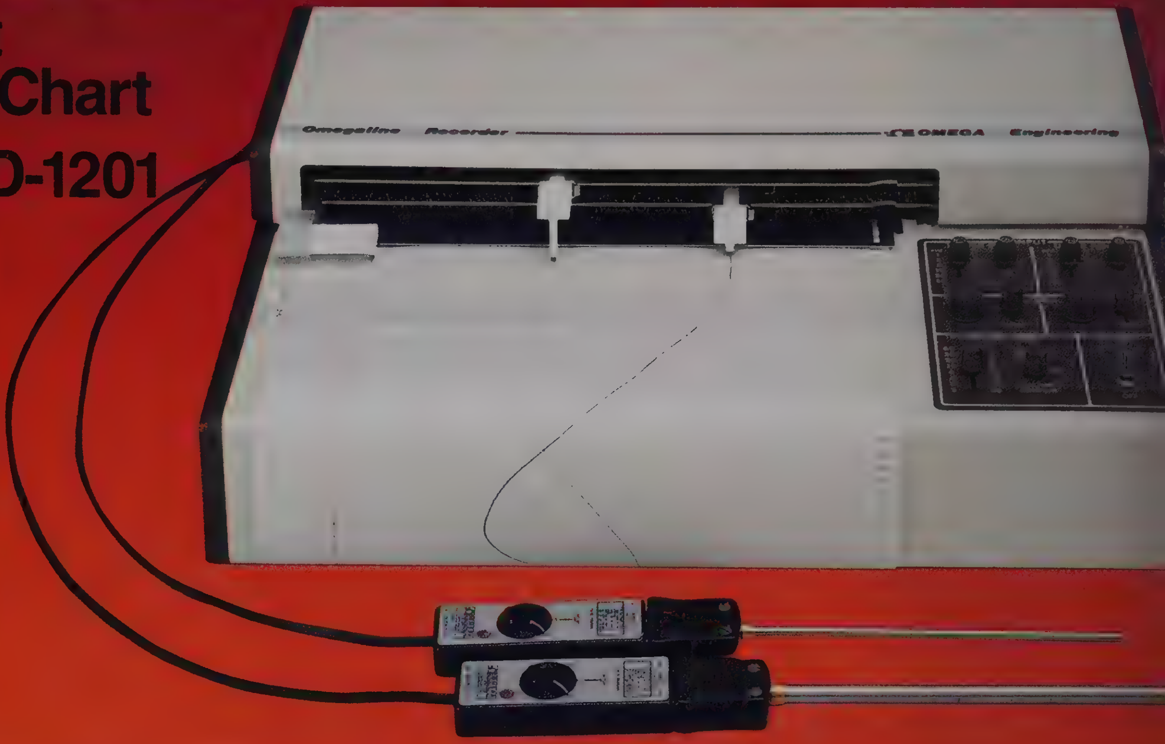
$625

One Channel

Model RD-1202

$995

Dual Channel



MODEL RD-1201 and RD-1202

Precision Design

- **16 Chart Speeds**
- **12 Input Spans**
- **±100% Zero Suppression**
- **1 Millivolt to 5 Volts—Variable Attenuator**
- **0.4 Second Pen Response**
- **Two Phase Stepper Motor Chart Drive**
- **Pulse Modulated Servo System**

The Model 1201 (1 pen) and **Model 1202** (2 pen) recorders are the newest and most dramatic in the line of intelligently priced recorders. This versatile recorder provides user with optimum flexibility, accuracy, and reliability.

In addition to the features listed above, Model RD-1201 and RD-1202 offer:

- **Convenient thermocouple input option (see next page)**
- **Override event marker**
- **Paper reversal control**
- **No overshoot—critically damped**
- **Remote chart programming (TTL)**
- **Zero switch**
- **Linearity accuracy less than 0.5%**

All of the performance and quality you could ask for in a single pen or dual pen recorder.

Thermocouple Probe and Electronic Ice Point extra. See Sections A and K.

General Specifications

Number of channels: One or two
Full Scale Spans: 1, 2, 5, 10, 20, 50, 100, 200, 500 mV; 1, 2, 5 volts
Impedance: 2.5 megohms
Accuracy
Deadband: Less than ±0.1%
Linearity: ±0.5%
Repeatability: Less than ±0.1%
Zero Setting: Continuously adjustable from −100% to +100%
Chart Drive: 16 speeds: 1, 2, 3, 6, 10, 15, 20, 30 cm/min and per hour
Control/Accuracy: Less than ±0.03%. External—can be remotely programmed by pulse train (TTL)
Writing System Type: Disposable cartridge, fiber tip
Response: 0.4 seconds F.S.
Drive: Potentiometric, null balance with sealed long life servo pot

Chart Width: 8″ (203 mm)
Dimensions: H: 4.38″ (111 mm) × W: 15″ (381 mm) × D: 10.5″ (267 mm
Weight: RD-1201: 9 pounds (4.1 kg) RD-1202: 11 pounds (5 kg)
Power: 115/230 V ac 50/60 Hz, 17.5 (RD-1201); 22.5 W (RD-1202)

Options: Order options 11, 13, 16, 20, 31, or 39. See page **N-39.**

How to Order

1. **Specify Model**
   One pen—
   Model RD-1201—$625
   Two pen—
   Model RD-1202—$995
2. **Select options:**
   Specify pens, paper, probes, or other options. See page **N-39.**

Accessories: *Keep extra pens and paper on hand.*

Each instrument is shipped with one roll of chart paper, one pen per input channel, and one instruction manual.

Chart Paper:	0 to 100 grid 25 meters long	No. 0100-0026	6 rolls/$36
Disposable Pens:	Short nib	Long nib	
Blue	No. 0100-0105	No. 0100-0109	6 pack/$10.75
Red	No. 0100-0106	No. 0100-0110	6 pack/$10.75
Black	No. 0100-0107	No. 0100-0111	6 pack/$10.75
Green	No. 0100-0108	No. 0100-0112	6 pack/$10.75
Dust Cover:	Clear	No. 0100-0209	each/$7.00

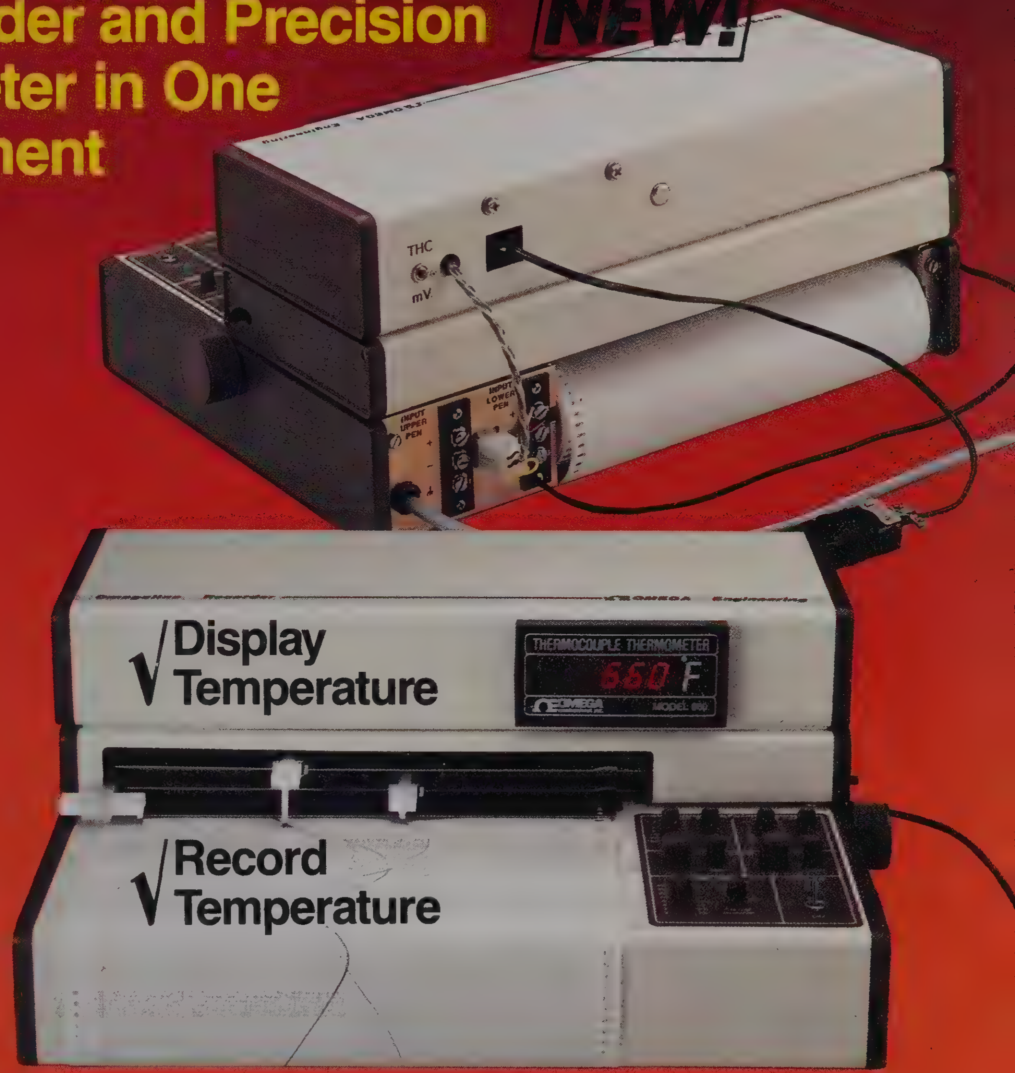
Works with Thermocouples! Use 1, 2, 5, 10, 20 or 50 mV range and a cold junction compensator or digital instrument with analog option as shown on next page.

Strip Chart Recorder and Precision Digital Thermometer in One Integrated Instrument

NEW!

- Linearized and Cold Junction Compensated
- Switch Selectable Thermocouple Type, °F/°C
- 1 mV/Degree Recording
- Easy-to-Read Digital Display

The Model 1200-660 Recorder/Thermometer units introduce new versaility to strip chart recorders. Now, have a digital display and a linearized, cold junction compensated chart recording of temperature at your fingertips. Three units are available: one channel recorder with one switchable thermocouple/mV input, two channel recorder with one switchable hermocouple/mV input and 1 mV only nput, and a two channel recorder with two switchable thermocouple/mV nputs. Each thermocouple input has ts own model 660 digital thermometer, which is DIP switch selectable for J, K, T, E, R or S thermocouple types and °C/°F readout. The chart recording is 1 mV/degree (C or F). To attach a thermocouple input, just plug in an easy-to-use SMP subminiature male connector (supplied) to the panel jack n the rear of the unit. These models are truly versatile, as you can easily disconnect the temperature input rom the recorder, and use it as a ypical millivolt strip chart recorder. In addition, with the RD-1202-660-2, you can record from two different thermocouple types simultaneously. The RD-1200-660 units can be operated with either 110 or 220 line voltage switch selectable).



$1495 **Model RD-1202-660-1** Shown
One thermocouple input and one mV input. Separate pen, event marker, option 11, add **$50**

All These Thermocouple Types are Available via an Easy-to-Use DIP Switch

SENSOR TYPE	MATERIAL TYPE	TEMPERATURE RANGE	RESOLUTION
J	Iron/Constantan	−165°C to 760°C −265°F to 1400°F	1°C 1°F
K	Chromel/Alumel	−50°C to 1250°C −58°F to 1999°F	1°C 1°F
T	Copper/Constantan	−150°C to 400°C −238°F to 752°F	1°C 1°F
E	Chromel-Constantan	−100°C to 870°C −148°F to 1598°F	1°C 1°F
R	PT 13% Rh/PT	0°C to 1760°C	1°C
S	PT 10% Rh/PT	32°F to 1999°F	1°F

Model 660 Specifications: See Pages M-21 and M-22

How to Order

RD-1201-660
One channel recorder with switchable thermocouple/mV input, and one model 660 digital thermometer **$1125**

RD-1202-660-1
Two channel recorder with one switchable thermocouple/mV input, and one mV only input, with one model 660 digital thermometer **$1495**

RD-1202-660-2
Two channel recorder with two switchable thermocouple/mV inputs, and two model 660 digital thermometers **$1895**

Strip Chart Recorders
Compact Flatbed

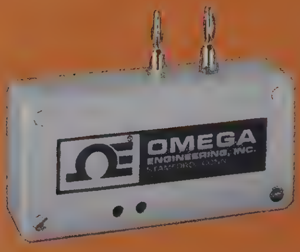
Model 156
$695

Precision Design
- **125 mm Chart Width**
- **1 mV to 10 V Span — 5 Settings**
- **Multiple Chart Speeds — 22 Settings**
- **< 1% Limit of Error**
- **> 50 cm/sec Pen Response**
- **Remote Chart On/Off Standard**

The Model 156 Strip Chart Recorder offers, as standard features, multiple chart speeds from 1 cm/hour to 30 cm/minute and multiple spans from 1 mV to 10 volts dc input.

This recorder incorporates the fine features of the standard 250 mm recorder but with the added compactness of a 125 mm chart width. The Model 156 also has ± 100% full scale zero suppression to allow up to 2 times the input on any range desired. And, by the flick of a switch, 115 or 230 volts ac at 50/60 Hz may be selected by the customer.

Simplicity, reliability, small size and low cost make this recorder a necessity when bench space is premium.



For more information on the OMEGA Thermocouple to Analog Convertor (TAC), see page N-23.

General Specifications
Number of Channels: 1
Full Scale Span: 1, 10, and 100 mV; 1.0 and 10 V; variable 10:1 attenuator
Input Type: Floating (± 100 volts single ended)
Input Impedance: 2.5 M Ω fixed
Chart Width: 125 mm
Chart Speeds: 22 speeds, switch selectable. Metric: 1, 2, 3, 4, 5, 6, 10, 12, 15, 20, 30 cm/min and cm/hr
Writing Method: Disposable fiber-tipped pen
Accuracy: Overall limit of error is < ± 1%
Response Time: 50 cm/sec., with source impedance less than 20 k Ω
Zero Adjust: Continuously adjustable from − 100% to + 100%
Power: 115/230 V ac, 50/60 Hz, 15 Watts
Dimensions: H: 4.75″ (120.6 mm) x W: 9″ (228:6 mm) x D: 11.5″ (292 mm)
Weight: 7.5 lbs (3.4 kg)
Accessories Furnished: One disposable pen, one roll chart paper, one instruction manual
Works with Thermocouples! Use 1 or 10 mV range and a cold junction compensator or a digital instrument with analog output.

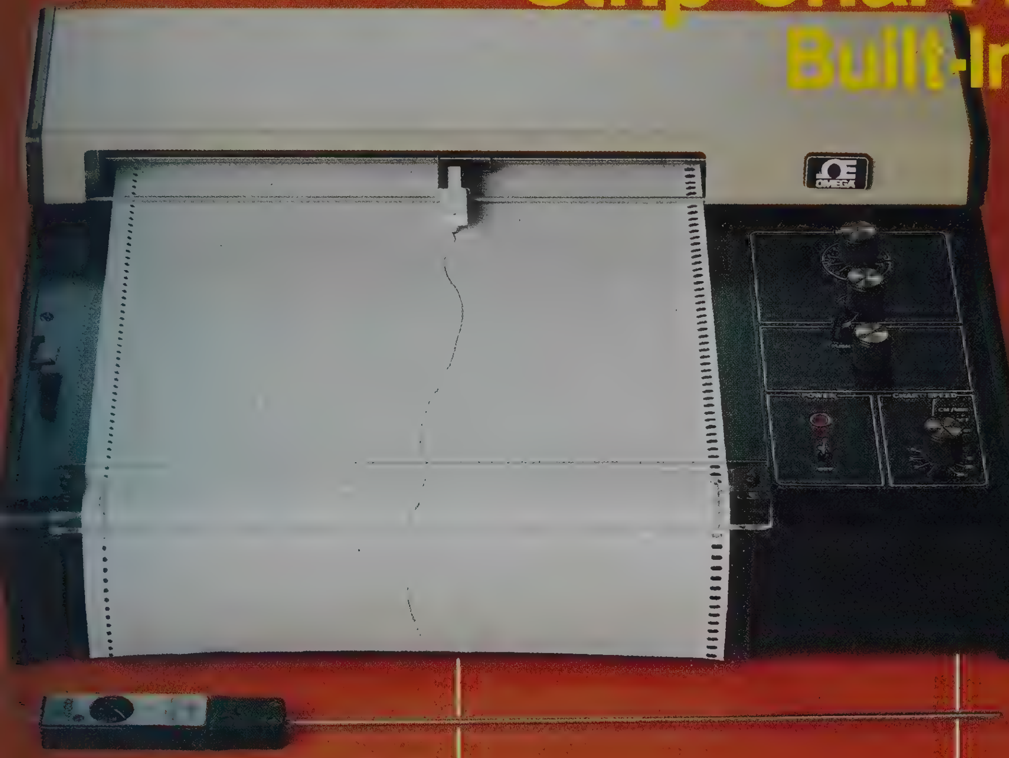
Options: Order options 11, 13, or 16. See Page **N-39**

How to Order:
Specify **Model 156 $695**
Select Options: See page **N-39**
Specify pens, paper, probes, or options by number.
Consult Sales Department for **Ice Point References, Thermocouples** and **Thermocouple Wire.**

Accessories: *Keep extra pens and paper on hand.*

Chart Paper:	0-100 grid, 30 meters long	No. 0100-0017	6 rolls/$36
Z-Fold Paper:	100 mm Wide	No. 0100-0028	1 pkg/$10
Disposable Pens:	Blue	No. 0100-0105	6 pack/$10.75
	Red	No. 0100-0106	6 pack/$10.75
	Black	No. 0100-0107	6 pack/$10.75
	Green	No. 0100-0108	6 pack/$10.75
Dust Cover:	Clear	No. 0100-0200	each/$7
Carrying Case:	Black	No. 0100-0184	each/$140

Strip Chart Recorders
Built-In Attenuator
One Pen
250mm Chart Width Laboratory Recorder



Model 555
$895

recision Design

22 Chart Speeds
12 Input Spans
±100% Zero Suppression
1 mV to 50 Volt — Variable Attenuator
0.5 Second Pen Response
Crystal Controlled Stepper Chart Drive
Pulse-modulated Servo System

he **Model 555** one pen laboratory ecorder is the newest and most ramatic in the line of intelligently riced recorders. Every possible eature has been included in this ersatile recorder to provide the ser with optimum flexibility, ccuracy, and long-term reliability.

n addition to the features listed Model 555 offers:

Electronic "servo kill"
Remote chart programming (TTL)
Zero switch
100% suppression (overranging)
Maximum limit of error less than 0.5%

ll of the performance and quality ou could ask for in a single pen ecorder!

hermocouple Probe and Electronic ce Point Extra.

General Specifications

Number of Channels: 1
Full Scale Spans: 1, 2, 5, 10, 20, 50, 100, 200, 500 mV; 1, 2, 5 Volts plus 10:1 attenuator to 50 Volts
Impedance: 20 M Ω through 100 mV, 2.5 M Ω through 5 Volts
Accuracy: Overall limit of error from all sources is less than 0.5%
Zero Setting: Continuously adjustable from −100% to +100%
Chart Drive 22 Speeds: 1, 2, 3, 4, 5, 6, 10, 12, 15, 20, 30 cm/min and per hour (direct reading in absolute time)
Control/Accuracy: Internal — crystal controlled External — can be remotely programmed by pulse train (TTL)
Writing System Type: Disposable cartridge, nylon tip
Response: ½ sec. F.S.
Drive: Potentiometric, null balance with sealed longlife servo pot
General Chart Width: 25 cm (10")
Dimensions: H: 5.5" (139.7 mm) x W: 17.75" (451 mm) x D: 14" (356 mm)
Weight: 12.5 lbs (5.7 kg)
Power: 115/230 V ac 50/60 Hz, 21 Watts

Options: Order options 11, 13, 16 or 20. See Page **N-39**

Works with Thermocouples! Use 1, 2, 5, 10, 20, or 50 mV range and a cold junction compensator or a digital instrument with analog output.

How to Order:

Specify **Model 555 $895**
Select Options: See page **N-39**
Specify pens, paper, probes, or options by number.
Consult Sales Department for **Ice Point References, Thermocouples** and **Thermocouple Wire.**

Accessories: *Keep extra pens and paper on hand.*

Each instrument is shipped with one roll of chart paper, one pen per input channel, and one instruction manual.

Proper matching of ink and paper is essential to provide records which have minimum bleeding or starvation and provide writing clarity over a wide range of temperature, relative humidity, and writing speeds. Our standard pens and paper provide these characteristics. We can provide both pens and paper to give excellent recording under the most demanding circumstances.

Paper:	100 grid, 30 m long	No. 0100-0025	6 rolls/**$36**
Pens:	Blue Short nib	No. 0100-0105	6 pack/**$10.75**
	Red Short nib	No. 0100-0106	6 pack/**$10.75**
	Black Short nib	No. 0100-0107	6 pack/**$10.75**
	Green Short nib	No. 0100-0108	6 pack/**$10.75**
Dust Cover:	Clear	No. 0100-0202	each/**$7**
Carrying Case:	Black	No. 0100-0183	each/**$160**

Strip Chart Recorders

Two Pen
250mm Chart Width Laboratory Recorder

Model 585
$1,295

Precision Design

- **2 Pen Recorder**
- **22 Chart Speeds**
- **12 Input Spans**
- **1 mV to 50 Volts**
- **0.5 Second Per Response**
- **Crystal Controlled Stepper Chart Drive**
- **Pulse Modulated Servo System**

The Model 585 two pen laboratory recorder is the newest and most dramatic in the line of intelligently priced recorders. Every possible feature has been included in this versatile recorder to provide the user with optimum flexibility, accuracy, and long-term reliability.

In addition to the features listed above, the Model 585 offers:

- Electronic "servo kill"
- Remote chart programming (TTL)
- Zero switch
- 100% supression (overranging)
- Maximum limit of error less than 0.5%

All of the performance and quality you could ask for at the price of many single pen recorders!

For more information on the OMEGA Thermocouple to Analog Converter (TAC), see page N-23.

General Specifications

Number of Channels: 2
Full Scale Span: 1, 2, 5, 10, 20, 50, 100, 200, 500 mV; 1, 2, 5, Volts plus 10:1 attenuator to 50 Volts each channel
Impedance: 20 M Ω through 100 mV, 2.5 M Ω through 5 Volts
Accuracy: Overall limit of error from all sources is less than 0.5%
Zero Setting: Continuously adjustable from −100% to +100%
Chart Drive 22 Speeds: 1, 2, 3, 4, 5, 6, 10, 12, 15, 20, 30 cm/min and per hour (direct reading in absolute time)
Control/Accuracy: Internal — crystal controlled oscillator driven chart. External — can be remotely programmed by pulse train (TTL)
Writing System Type: Disposable cartridge, nylon tip.
Response: ½ sec. F.S.
Drive: Potentiometric, null balance with sealed long-life servo pot
General Chart Width: 25 cm (10″)
Dimensions: H: 5.5″ (139.7 mm) x W: 17.75″ (451 mm) x D: 14″ (355.6 mm)
Weight: 14.5 lbs (6.58 kg)
Power: 115/230 V ac 50/60 Hz, 29 Watts

Options: Order options 11, 13, 16 o

See page **N-39**

How to Order:

Specify **Model 585 $1,295**
Select Options: See page **N-39**
Specify pens, paper, probes, or options by number.
Consult Sales Department for **Ice Point References, Thermocouple** and **Thermocouple Wire.**

Accessories: *Keep extra pens and paper on hand.*

Each instrument is shipped with one roll of chart paper, one pen per input channel, and one instruction manual. Electronic event marker is standard on channel 1.

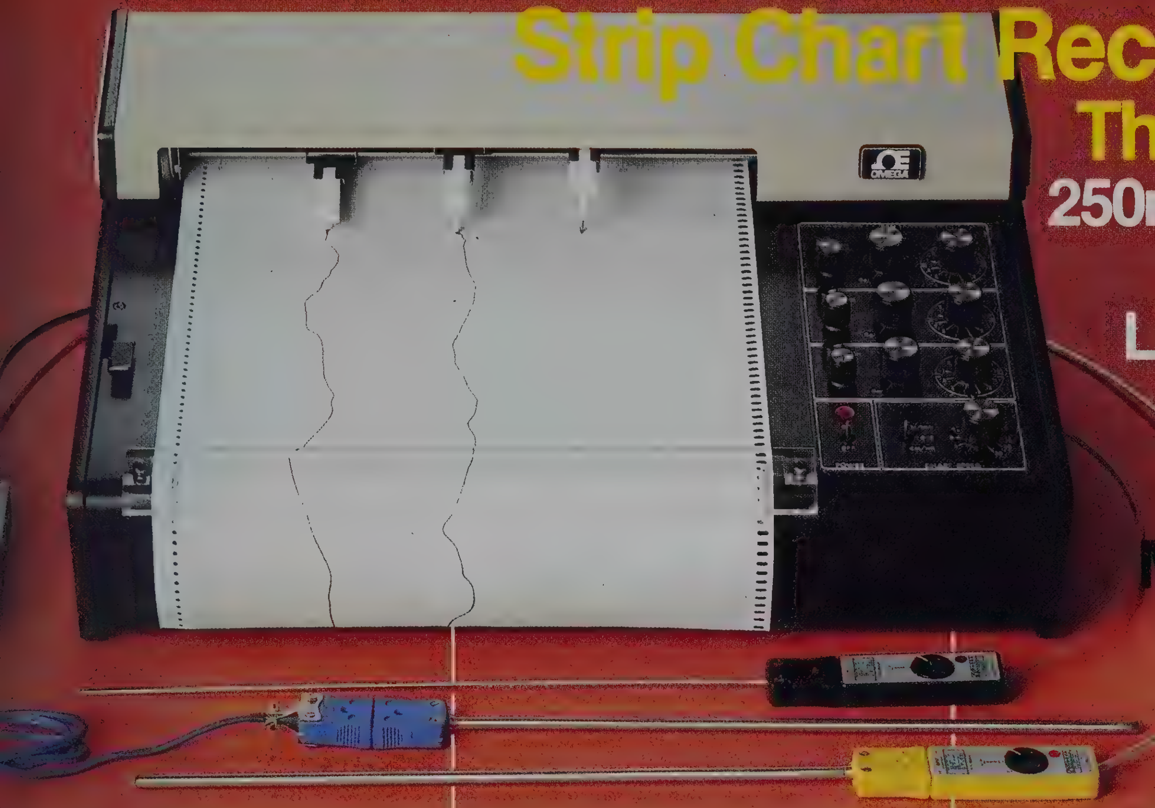
Proper matching of ink and paper is essential to provide records which have minimum bleeding or starvation and provide writing clarity over a wide range of temperature, relative humidity, and writing speeds. Our standard pens and paper provide these characteristics. We can provide both pens and paper to give excelle recording under the most demanding circumstances.

Paper:	100 grid, 30 m long	No. 0100-0025	6 rolls/$36
Pens:			
	Short nib	Long nib	
Blue	No. 0100-0105	0100-0109	6 pack/$10.75
Red	No. 0100-0106	0100-0110	6 pack/$10.75
Black	No. 0100-0107	0100-0111	6 pack/$10.75
Green	No. 0100-0108	0100-0112	6 pack/$10.75
Dust Cover:	Clear	No. 0100-0202	each/$7
Carrying Case:	Black	No. 0100-0183	each/$160

Works with Thermocouples! Use 1, 2, 5, 10, 20, or 50 mV range and a cold junction compensator or a digital instrument with analog output.

Strip Chart Recorders

Three Pen 250mm Chart Width Laboratory Recorder



Model 595

$1,850

recision Design

- 3 Pen Recorder
- 22 Chart Speeds
- 12 Input Spans
- 1 mV to 50 Volts — Variable Attenuator
- 0.5 Second Pen Response
- Crystal Controlled Stepper Chart Drive
- Pulse-modulated Servo System

he Model 595 three pen laboratory ecorder is the newest and most ramatic in the line of intelligently riced recorders. Every possible eature has been included in this ersatile recorder to provide the ser with optimum flexibility, ccuracy, and long-term reliability.

n addition to the features listed bove, the Model 595 offers:

- Electronic "servo kill"
- Remote chart programming (TTL)
- Zero switch
- 100% suppression (overranging)
- Maximum limit of error less than 0.5%

ll of the performance and quality ou could ask for at the price of nany single pen recorders!

hermocouple Probe and Electronic ce Point Extra.

General Specifications

Number of Channels: 3

Full Scale Spans: 1, 2, 5, 10, 20, 50, 100, 200, 500 mV; 1, 2, 5, Volts plus 10:1 attenuator to 50 Volts each channel

Impedance: 20 M Ω through 100 mV, 2.5 M Ω through 5 Volts

Accuracy: Overall limit of error from all sources is less than 0.5%

Zero Setting: Continuously adjustable from −100% to +100%

Chart Drive 22 Speeds: 1, 2, 3, 4, 5, 6, 10, 12, 15, 20, 30 cm/min and per hour (direct reading in absolute time)

Control/Accuracy: Internal — crystal controlled. External — can be remotely programmed by pulse train (TTL).

Writing System Type: Disposable cartridge, nylon tip

Response: ½ sec. F.S.

Drive: Potentiometric, null balance with sealed long-life servo pot

General Chart Width: 25 cm (10″)

Dimensions: H: 5.5″ (139.7 mm) x W: 17.75″ (451 mm) x D: 14″ (355.6 mm)

Weight: 17 lbs (7.7 kg)

Power: 115/230 V ac 50/60 Hz, 38 Watts

Options: Order options 13, 16, or 20. See page **N-39**

How to Order:

Specify **Model 595 $1,795**
Select Options: See page **N-39**
Specify pens, paper, probes, or options by number.
Consult Sales Department for **Ice Point References, Thermocouples** and **Thermocouple Wire.**

Accessories: *Keep extra pens and paper on hand.*

Each instrument is shipped with one roll of chart paper, one pen per input channel, and one instruction manual. Electronic event marker is standard on channel 1.

Proper matching of ink and paper is essential to provide records which have minimum bleeding or starvation and provide writing clarity over a wide range of temperature, relative humidity, and writing speeds. Our standard pens and paper provide these characteristics. We can provide both pens and paper to give excellent recording under the most demanding circumstances.

Paper:	100 grid, 30 m long	No. 0100-0025	6 rolls/$36
Pens:	Blue Short nib	No. 0100-0105	6 pack/$10.75
	Red Short nib	No. 0100-0106	6 pack/$10.75
	Black Med. nib	No. 0100-0131	6 pack/$10.75
	Green Long nib	No. 0100-0132	6 pack/$10.75
Dust Cover:	Clear	No. 0100-0202	each/$7
Carrying Case:	Black	No. 0100-0183	each/$160

Works with Thermocouples! Use 1, 2, 5, 10, 20, or 50 mV range and a cold junction compensator or a digital instrument with analog output.

Strip Chart Recorders

Price List and Accessories

Recorders

Model	Description	Price
141	Portable, ac powered, single channel	$755
142	Portable, ac/dc, single channel	895
143	Compact recording, single channel	595
145	4″ Type J thermocouple or mV input, single channel	420
	4″ mV input only, single channel	295
146	4″ Type J thermocouple or mV input, single channel	745
	4″ mV input only, dual channel	495
156	5″ Compact flatbed, single channel	695
456	10″ Vertical rack or bench mount, single channel	995
486	10″ Vertical rack or bench mount, dual channel	1,295
555	10″ Deluxe flatbed, single channel	895
585	10″ Deluxe flatbed, dual channel	1,295
595	10″ Deluxe flatbed, triple channel	1,850
1201	8″ Flatbed, single channel	625
1202	8″ Flatbed, dual channel	995

Options

Model	Description	Price
Option 11	Separate pen, event marker (not available in Series 140, Series 400, Model 595)	$ 50
Option 13	Remote/electric pen lift (not available in 140 Series)	50
Option 16	Electronic override event marker (not available in 140 Series), Standard on channel 1, Optional for other channels Models 486, 585, 595.	40
Option 20	1000% Zero suppression (for Series 400 and 500 only) price per channel	150
Option 31	Paper tear-off bar for Models 141, 142, and 143.	35
Option 39 (Field Installable)	Z-fold paper tray. Replaces regular chart drive assembly Models 141, 142, and 143.	25
Option 50 (Field Installable)	Protective door for Models 141 and 142 Model 143.	25 35
Option 660-1	Thermocouple thermometer for Models 1201 or 1202.	500
Option 660-2	Thermocouple thermometer for Model 1202.	900

Pens

Fiber-tipped Pens, Round

Model	Description	Price
0100-0101	Blue fiber tip	6 pack/$10.75
0100-0102	Red fiber tip	6 pack/ 10.75
0100-0103	Black fiber tip	6 pack/ 10.75
0100-0104	Green fiber tip	6 pack/ 10.75

Round pens are used on Model 156, recorders.

Short Nib Pens, Rectangular Body

Model	Description	Price
0100-0105	Blue fiber tip	6 pack/$10.75
0100-0106	Red fiber tip	6 pack/ 10.75
0100-0107	Black fiber tip	6 pack/ 10.75
0100-0108	Green fiber tip	6 pack/ 10.75

Short nib pens are used on Model 141, 142, 143, 145, 146, 456, 555, 1201, 1202 recorders. 0100-0105 pens are used on all multipen recorders.

Long Nib Pens, Rectangular Body

Model	Description	Price
0100-0109	Blue fiber tip	6 pack/$10.75
0100-0110	Red fiber tip	6 pack/ 10.75
0100-0111	Black fiber tip	6 pack/ 10.75
0100-0112	Green fiber tip	6 pack/ 10.75

Long nib rectangular pens are used on Model 145, 146, 486, 585, 1201, 1202 recorders. One short nib and one long nib are required for normal operation.

Model 595 Recorder Pen Set

Model	Description	Price
0100-0105	Blue fiber tip, rectangular body, short	6 pack/$10.75
0100-0131	Black fiber tip, rectangular body, medium	6 pack/ 10.75
0100-0132	Green fiber tip, rectangular body, long	6 pack/ 10.75

Miscellaneous

Model	Description	Price
0100-0200	Dust cover for Model 156 recorders	$ 7
0100-0202	Dust cover for Series 500 recorders	7
0100-0203	Dust cover for Model 141 and 142 recorders	7
0100-0209	Dust cover for Model 1201 and 1202 recorders.	7
0100-0184	Transport case for 5" Flatbed recorders	140
0100-0183	Transport case for 10" Flatbed recorders	160

HOW TO ORDER: Thermocouple to Analog Converter (TAC)

TAC-386-J — J	thermocouple input	$125
TAC-386-K — K	thermocouple input	125
TAC-386-T — T	thermocouple input	125

Battery Included See Page **N-23**

Infrared to Analog Converter

OS-500F	$360
OS-500C	360

Battery Included See Page **C-26**

Strip Chart Recorders
OMEGALINE™ Precision Laboratory Recorders

Omegaline Recorder
OMEGA Engineering
ZERO
CHECK
VOLTS mV FULL SCALE
POWER
OFF
CHART
TYPE T THERMOCOUPLE THERMOMETER
OMEGA
MODEL 650
OFF

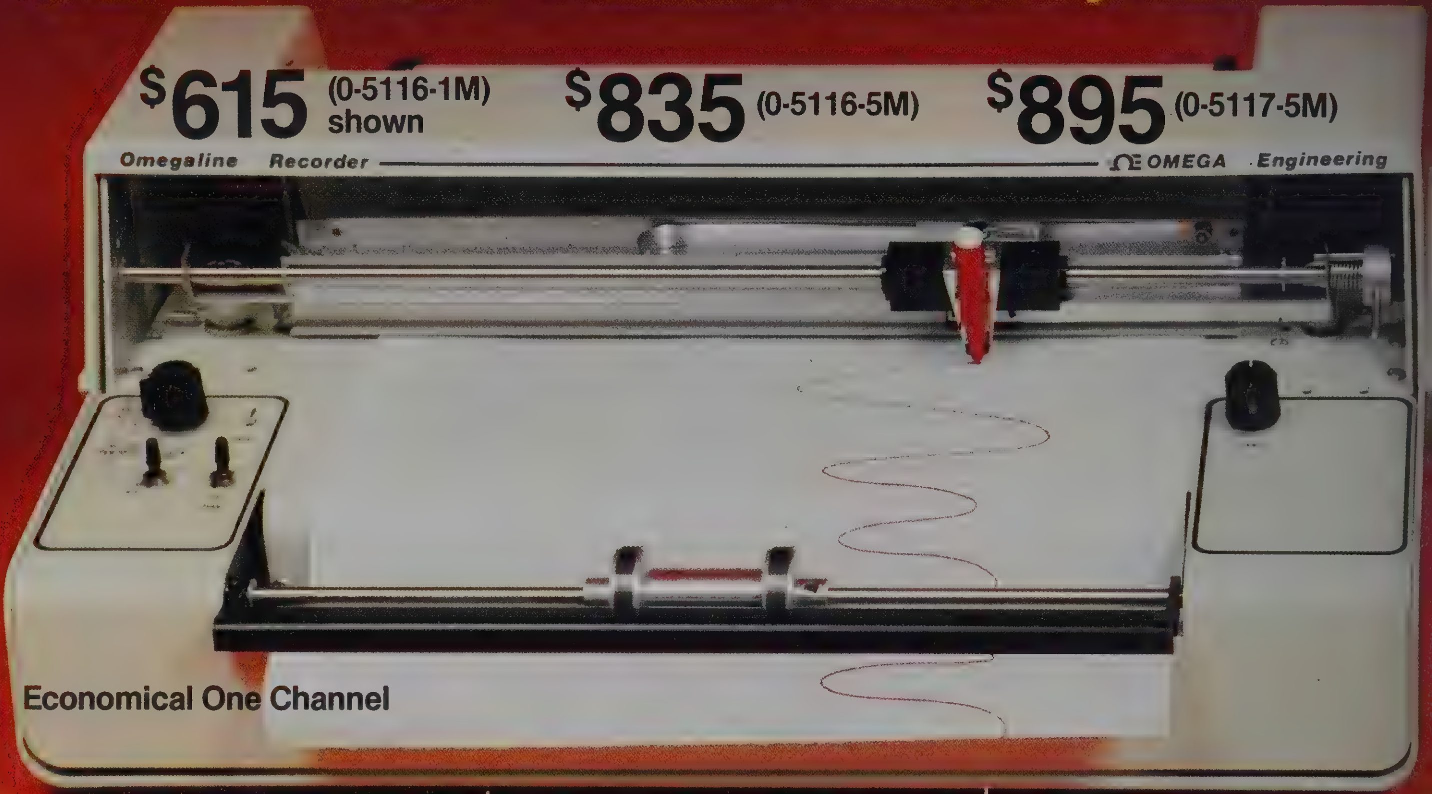
Prices start at:

$585

One and Two Channel Models Available

Fast Deliveries
Instruments are
OFF-THE-SHELF

Strip Chart Recorders
OMEGALINE™ Precision Laboratory Recorders



$615 (0-5116-1M) shown

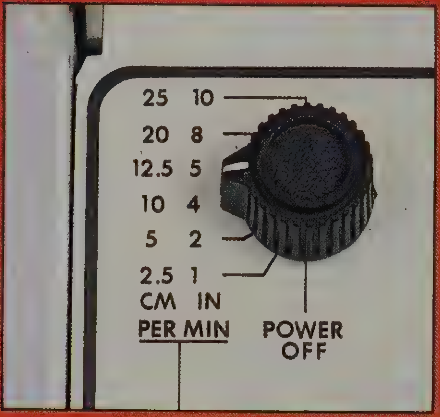
$835 (0-5116-5M)

$895 (0-5117-5M)

Economical One Channel

Model 0-5116-5M
One Channel 250 mm Chart Width
Five Millivolt Ranges:
1, 10, and 100 mV, 1 and 10V

SIX CHART SPEEDS



To Order:
Specify **Model 0-5116-5M** $835

Also Available:
Model 0-5116-1M
Single Pen, Six Chart Speeds,
10 mV Fixed Sensitivity. $615

For more information on the OMEGA Thermocouple to Analog Converter (TAC), see page N-23

Precision Design

- Web Feed Chart Drive — Accurate, reliable, self-aligning. A time tested adaptation of precision paper feeds.
- Simple chart loading.
- Sprocketless Paper — The web feed also allows use of sprocketless paper. Gives a fileable, standard size record without annoying or expensive sprocket holes.
- Integral Tear Bar
- Zero Offset — 10% to 110%

Quality

- Rugged Metal Cover
- Enameled Aluminum Case
- Stainless Steel Fittings
- Disposable Fiber-tipped Pens

Reliability

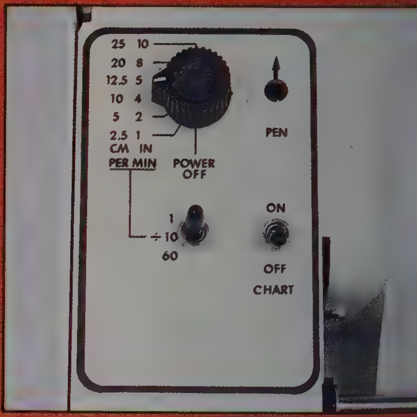
- Permanently Lubricated Bearings
- Pen Drive with Overdrive Clutch
- Infinite Resolution Non-contact Rebalance Element

Thermocouple Inputs
The OMEGALINE™ recorders are ideally suited to work with thermocouples in one of two configurations: 1): Using a digital thermometer with a linearized analog output will provide direct temperature readings. 2) Using an electronic cold junction compensator (OMEGA CJ or MCJ) will provide ice point referenced millivolts which can be converted to temperature.

Each OMEGALINE™ recorder is supplied with the latest OMEGA edition of the NBS temperature-millivolt conversion tables for thermocouples.

Model 0-5117-5M
One Channel 250 mm Chart Width
Five Millivolt Ranges:
1, 10, and 100 mV, 1 and 10V

SEVENTEEN CHART SPEEDS



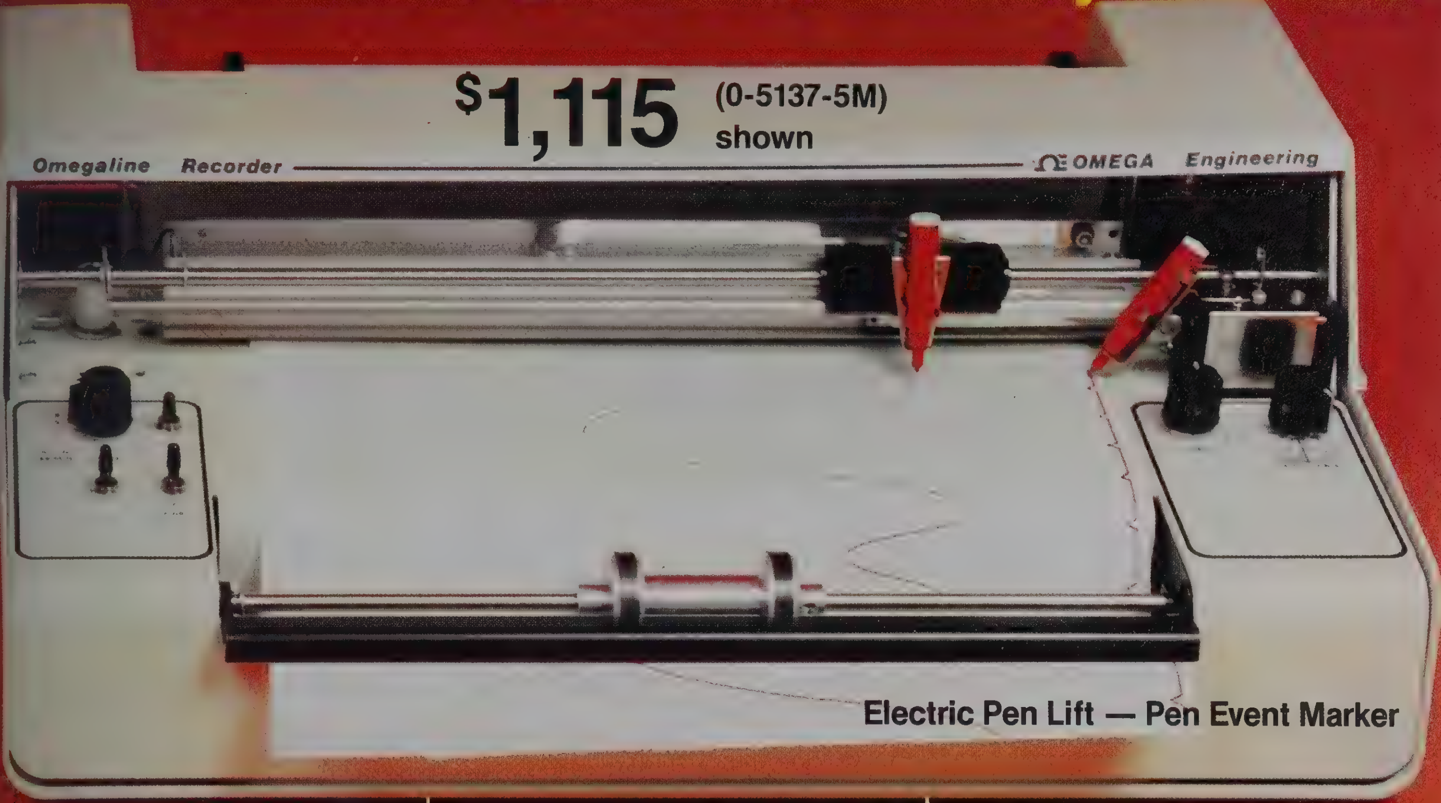
To Order:
Specify **Model 0-5117-5M** $89

Accessories: See Page **N-45**
Dust Cover $1
VARI-SPAN™ input adaptor
A-9 $85
A-9-A $10
Paper and Pens, Page **N-45**

You can order an MCJ cold junction compensator OFF-THE-SHELF for every thermocouple calibration.

Strip Chart Recorders

OMEGALINE™ Precision Laboratory Recorders



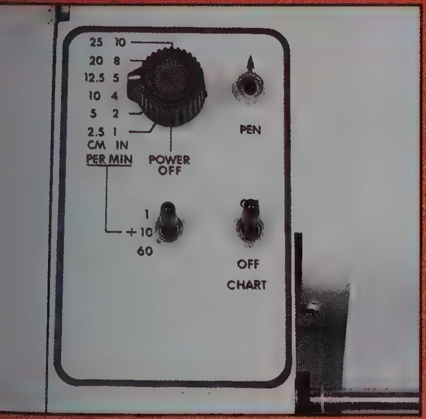
$1,115 (0-5137-5M) shown

Electric Pen Lift — Pen Event Marker

odel 0-5137-5M

ne Channel 250 mm Chart Width
ive Millivolt Ranges:
, 10, 100 mV, 1, 10V

EVENTEEN CHART SPEEDS



o Order:

pecify **Model 0-5137-5M**	**$1,115**

ccessories: See Page **N-45**

ust Cover	**$10**
ARI-SPAN™ input adaptor	
A-9	**$85**
A-9-A	**$100**

aper and Pens, Page **N-45**

ou can order an MCJ cold junction ompensator OFF-THE-SHELF for every ermocouple calibration.

Precision Design

- Web Feed Chart Drive — Accurate, reliable, self-aligning. A time-tested adaptation of precision paper feeds.
- Simple chart loading.
- Sprocketless Paper — The web feed also allows use of sprocketless paper. Gives a fileable, standard size record without annoying or expensive sprocket holes.
- Integral Tear Bar
- Zero Offset – 10% to 110%

Quality

- Rugged Metal Cover
- Enameled Aluminum Case
- Stainless Steel Fittings
- Disposable Fiber-tipped Pens

Reliability

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- Pen Drive with Overdrive Clutch
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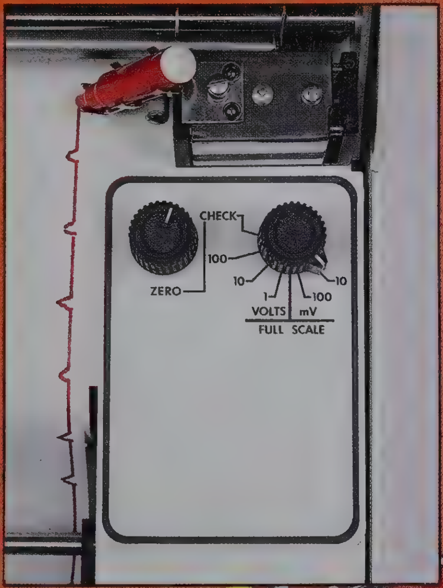
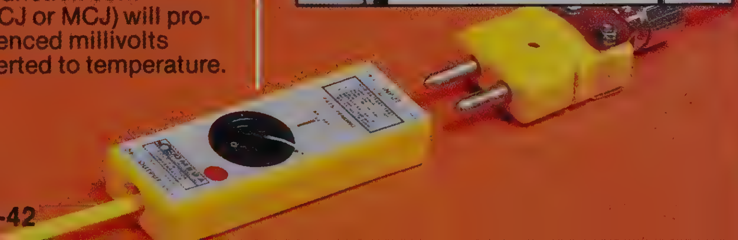
Each OMEGALINE™ recorder is supplied with the latest OMEGA edition of the NBS temperature-millivolt conversion tables for thermocouples.

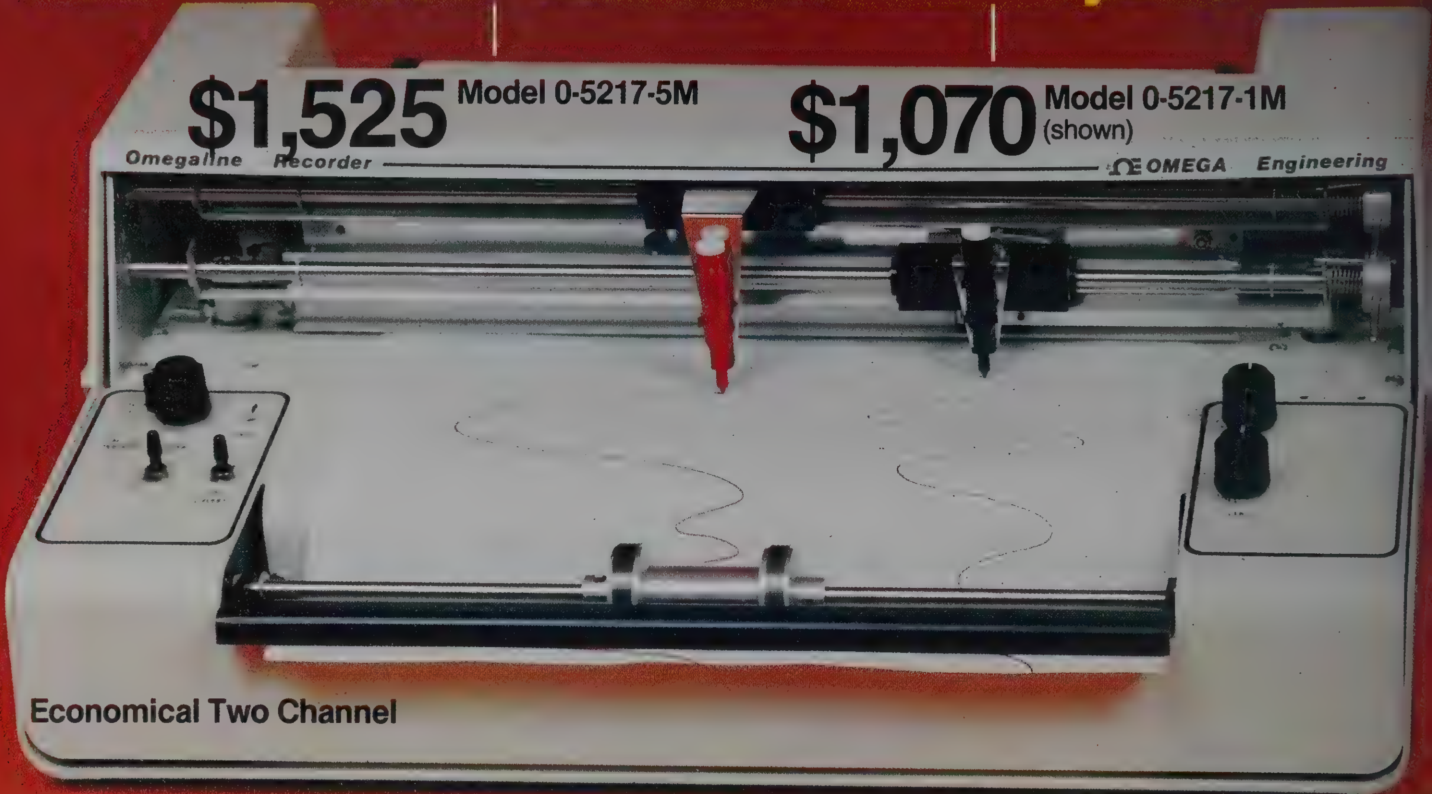
Event Marker

Right Hand Event Marker close-up showing zero adjust and full scale span selection.



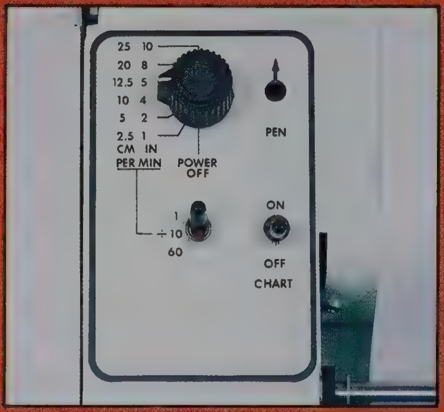


Strip Chart Recorders
OMEGALINE™ Precision Laboratory Recorders


$1,525 Model 0-5217-5M
$1,070 Model 0-5217-1M (shown)
Omegaline Recorder
Ω OMEGA Engineering
Economical Two Channel

Model O-5217-5M
Two Channel 250 mm Chart Width
Five Millivolt Ranges:
1, 10, 100 mV, 1, 10 V

SEVENTEEN CHART SPEEDS


25 10
20 8
12.5 5
10 4
5 2
2.5 1
CM IN
PER MIN
POWER
OFF
PEN
1
÷10
60
ON
OFF
CHART

To Order:

Specify **Model 0-5217-5M**	**$1,525**

Accessories: See Page N-35

Dust Cover	**$10**
VARI-SPAN™ input adaptor	
A-9	**$85**
A-9-A	**$100**
Paper and Pens, Page **N-35**	

Precision Design
- Web Feed Chart Drive — Accurate, reliable, self-aligning. A time tested adaptation of precision paper feeds.
- Simple chart loading.
- Sprocketless Paper — The web feed also allows use of sprocketless paper. Gives a fileable, standard size record without annoying or expensive sprocket holes.
- Integral Tear Bar
- Zero Offset — 10% to 110%

Quality
- Rugged Metal Cover
- Enameled Aluminum Case
- Stainless Steel Fittings
- Disposable Fiber-tipped Pens

Reliability
- Permanently Lubricated Bearings
- Pen Drive with Overdrive Clutch
- Infinite Resolution Non-contact Rebalance Element

Thermocouple Inputs
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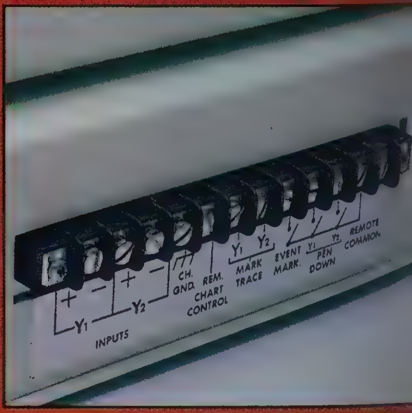
Model O-5217-1M (shown)
Two Channel Fixed 10 mV Range
Seventeen Chart Speeds

To Order:

Specify **Model 0-5217-1M**	**$1,07**

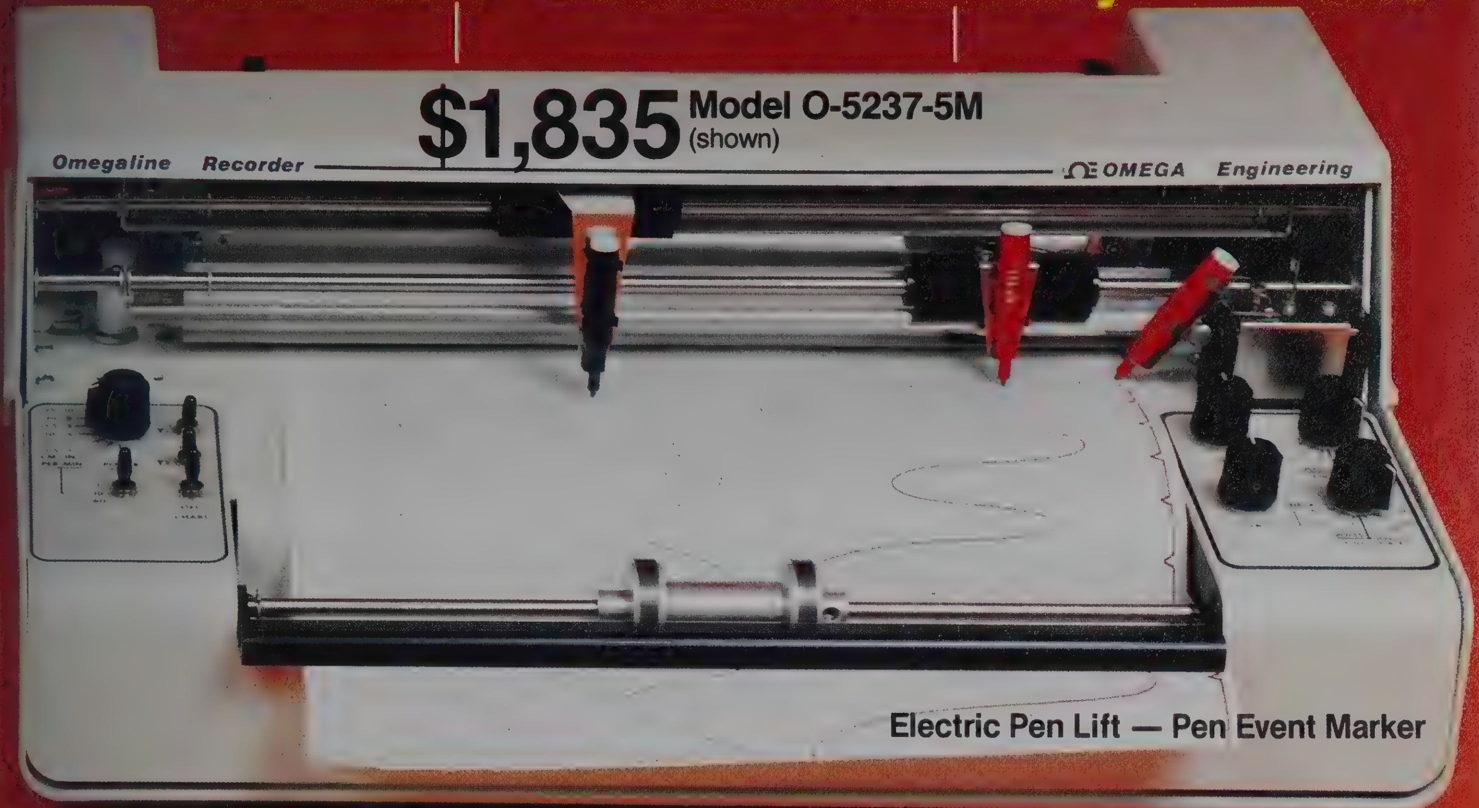
EASY CONNECTIONS ALL OMEGALINE™ MODELS


+
−
+
−
Y1
Y2
INPUTS
CH. GND.
REM. CHART CONTROL
Y1 Y2
MARK TRACE
EVENT MARK
Y1 Y2
PEN DOWN
REMOTE COMMON

You can order an MCJ cold junction compensator OFF-THE-SHELF for every thermocouple calibration.

Strip Chart Recorders

OMEGALINE™ Precision Laboratory Recorders


Omegaline Recorder
OMEGA Engineering

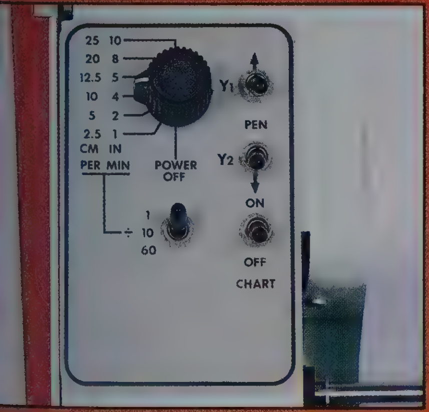
$1,835 Model O-5237-5M (shown)

Electric Pen Lift — Pen Event Marker

Model O-5237-5M

wo Channel 250 mm Chart Width
ive Millivolt Ranges:
, 10, and 100 mV, 1 and 10 V

LECTRIC PEN LIFT
EVENTEEN CHART SPEEDS


25 10
20 8
12.5 5
10 4
5 2
2.5 1
CM IN
PER MIN
POWER
OFF
1
÷ 10
60
Y1
PEN
Y2
ON
OFF
CHART

o Order:

pecify **Model 0-5237-5M** **$1,835**

Accessories: Page N-35

ust Cover	$10
ARI-SPAN™ input adaptor	
A-9	$85
A-9-A	$100

aper and Pens, Page N-35

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Precision Design

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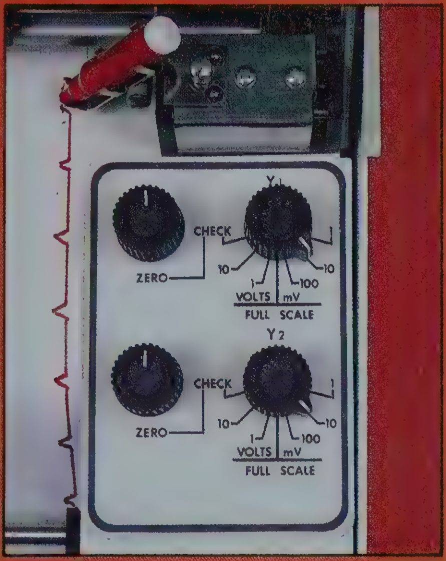
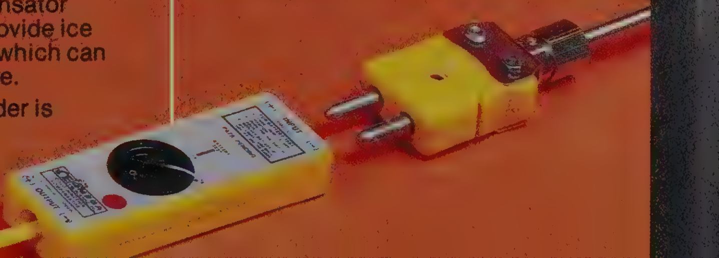
Right Hand Event Marker close-up showing zero adjust and full scale span selection.


Y1
CHECK
ZERO
10
1
10
100
VOLTS mV
FULL SCALE
Y2
CHECK
ZERO
10
1
10
100
VOLTS mV
FULL SCALE



Strip Chart Recorders
OMEGALINE™ Accessories

Paper

Quantity	Price Per Roll EC	Price Per Roll ECP*
1-3 Rolls	**$9.00**	**$9.25**
4 Rolls/Box		
1-3 Boxes	**8.25**	**9.00**
4-11 Boxes	**8.00**	**8.25**
12-23 Boxes	**7.75**	**8.00**
24 Rolls/Carton		
1-2 Cartons	**7.25**	**7.50**
3-4 Cartons	**7.00**	**7.25**
5-10 Cartons	**6.75**	**7.00**
11-20 Cartons	**6.50**	**6.75**
21-40 Cartons	**6.25**	**6.50**
41-Up	**Consult Sales Department**	

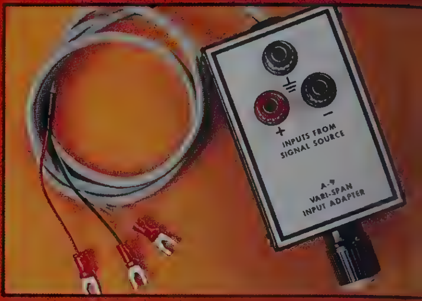
**P means perforated*

NOTE: *Each box or carton must be all one type to qualify for quantity discount.*

Pens

Pen Pkg.	Price	Description
P-494	**$10**	Four Black
P-495	**10**	Four Red
P-496	**10**	Four Green
P-497	**10**	Four Blue
P-498	**10**	One each color
P-499	**10**	Two Red, Two Black

Snap-on disposable felt-tipped pens are sold only in packages of four. Fits one and two pen recorders and event marker.



VARI-SPAN™ INPUT ADAPTER

The A-9 VARI-SPAN™ Input Adapte

The A-9 VARI-SPAN™ Input Adapter allows additional versatility in handling electrical signals received by the recorder that exceed the basic recorder ranges.

Let's assume, for example, that one has an OMEGALINE™ Recorder with a multirange input feature offering 1, 10, 100 mV, and 1 and 10 V. If this instrument was receiving a 50 mV signal with the input range selector switch positioned on the 100 mV setting, the pen would advance to 50% of full scale. On the other hand, if the range selector were positioned on the 10 mV setting, the pen would go off scale. Using the VARI-SPAN™ adapter the signal can be adjusted to give 100% deflection on the 10 mV setting.

Catalog No. A-9 **$85**

The A-9-A ACCU-SPAN™ Variable Input Adapter

For even more precise and accurate work, the ACCU-SPAN is equipped with a calibrated dial which permits accurate setting of an input range and at the same time allows exact resetting to any previously selected attenuation level. Each full turn of the ten-turn control is identified by a small number appearing in a window on the control housing. The dial knob itself is calibrated from 0-100.

Catalog No. A-9-A **$100**

Specifications All Models

Y AXIS

Input Characteristics: Isolated and floating to ±200 Volts
Input Resistance: (Fixed Range: >100MΩ) Ω, Multispan units: 1 MΩ
Zero Offset: −10% to +110% full scale with 10-turn control
Response: 0.5 sec to 90% of full scale
Slew Speed: 50 cm/sec nominal
Pen Offset: (Two pen units) 0.5″ (12.7mm)
Rejection Ratios:
dc common mode ±120 dB
ac common mode ±120 dB
ac normal mode >60 dB
Repeatability (Dead Zone): ±0.1% of full scale
Linearity: ±0.2% of full scale
Overall Accuracy: ±0.3% of full scale
Overshoot: Critically damped 1% typical. Max. of 2% on full scale

X AXIS

Recording Width: 250 mm (10″)
Charts: Metric, 279 mm x 30 m
English, 11″ x 100′
Chart Speed Accuracy: 0.1%
Weight: 22 lbs (5.4 kg)
Dimensions: H: 6″ (152 mm) x W: 17″ (432 mm) x D: 12″ (305 mm)
Power: 115/230 V ac, ±10%, 50/60 Hz, 50 VA for one pen, 70 VA for two pen.

Popular Chart Paper

Each roll is 11 inches wide by 100 feet long. Four rolls are packaged to a box with six boxes to a carton (24 rolls).

Types		Time Axis		Amplitude Axis			
Continuous	Perforated Every 8½″	Major Divisions Every	Minor Divisions Per Major	Grid Width	Major Divisions	Minor Divisions	Numbering
EC-0	ECP-0	1 In.	None	Blank	None	None	None
EC-100	ECP-100	1 In.	5	10 In.	10	100	0-10
EC-101	ECP-101	1 In.	6	10 In.	10	100	0-10
EC-102	ECP-102	1 Cm.	6	25 Cm.	25	250	None
EC-103	ECP-103	1 Cm.	6	25 Cm.	10	100	0-10
EC-104	ECP-104	1 Cm.	6	25 Cm.	10	100	None
EC-106	ECP-106	1 In.	6	10 In.	10	100	None
		100 feet total length		standard 11 inches overall width			

Continuous roll paper can be torn at any length using the tear bar on the recorder.

Perforated paper reduces to a standard paper size of 8½″ x 11″ and can be torn when removed from recorder. It may also be fan folded to improve display.

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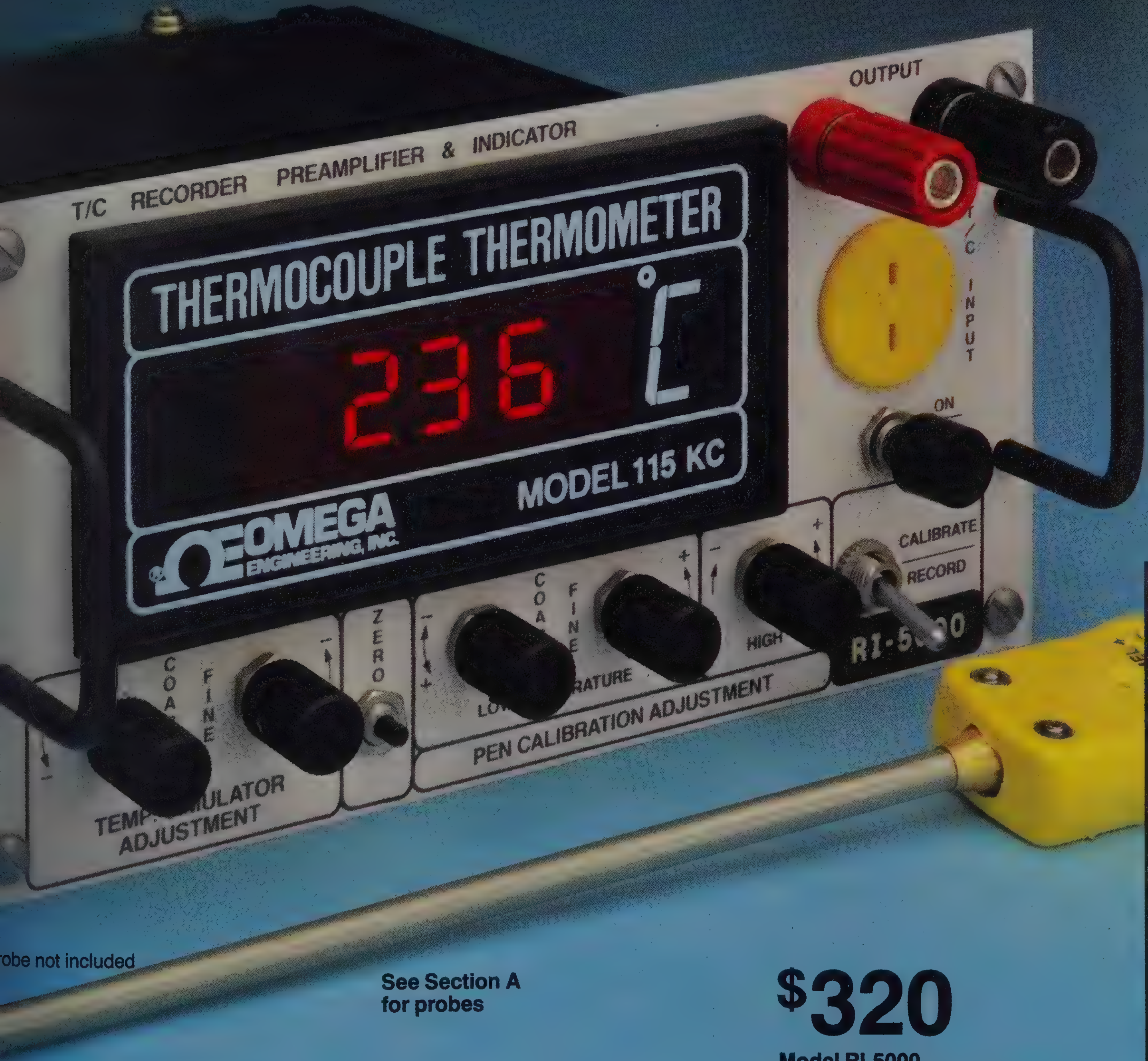
Thermocouple/Recorder Interface

Converts Millivolt Recorders to Linearized Temperature Recorders

- One, Two, or Three Channels to Match Your Recorder
- Bench or Panel Styles
- Linear Temperature Output
- 100% Zero Offset
- Expanded Scales
- Works as a Calibrator too!


T/C RECORDER PREAMPLIFIER & INDICATOR
THERMOCOUPLE THERMOMETER
236 °C
MODEL 115 KC
OMEGA ENGINEERING, INC.
OUTPUT
T/C INPUT
ON
CALIBRATE
RECORD
RI-5000
HIGH
COARSE
FINE
LOW
RATURE
PEN CALIBRATION ADJUSTMENT
ZERO
TEMP. ULATOR ADJUSTMENT

robe not included

See Section A for probes

$320

Model RI-5000
One Channel Rack Mount

YES!

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☐ 1984 Temperature Measurement Handbook and Encyclopedia™

☐ 1984 Pressure Measurement Handbook

☐ Temperature Developments

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Dept. ______ Mail Stop No. ______
Co. Address ______
City ______ State ______ Zip ______
Signature ______

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City ______ State ______ Zip ______

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☐ Production, Manufacturing, or Process Engineering
☐ Packaging, Quality Control (including management)
☐ Engineering, Design (including management)
☐ Research and Development (including management)
☐ Purchasing (including management)
☐ General Management and Administration ☐ Sales office
☐ Student ☐ Professor ☐ Librarian ☐ Other ______
☐ Consultant

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Please send me
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☐ Temperature Developments

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City ______ State ______ Zip ______
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City ______ State ______ Zip ______

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☐ Consultant

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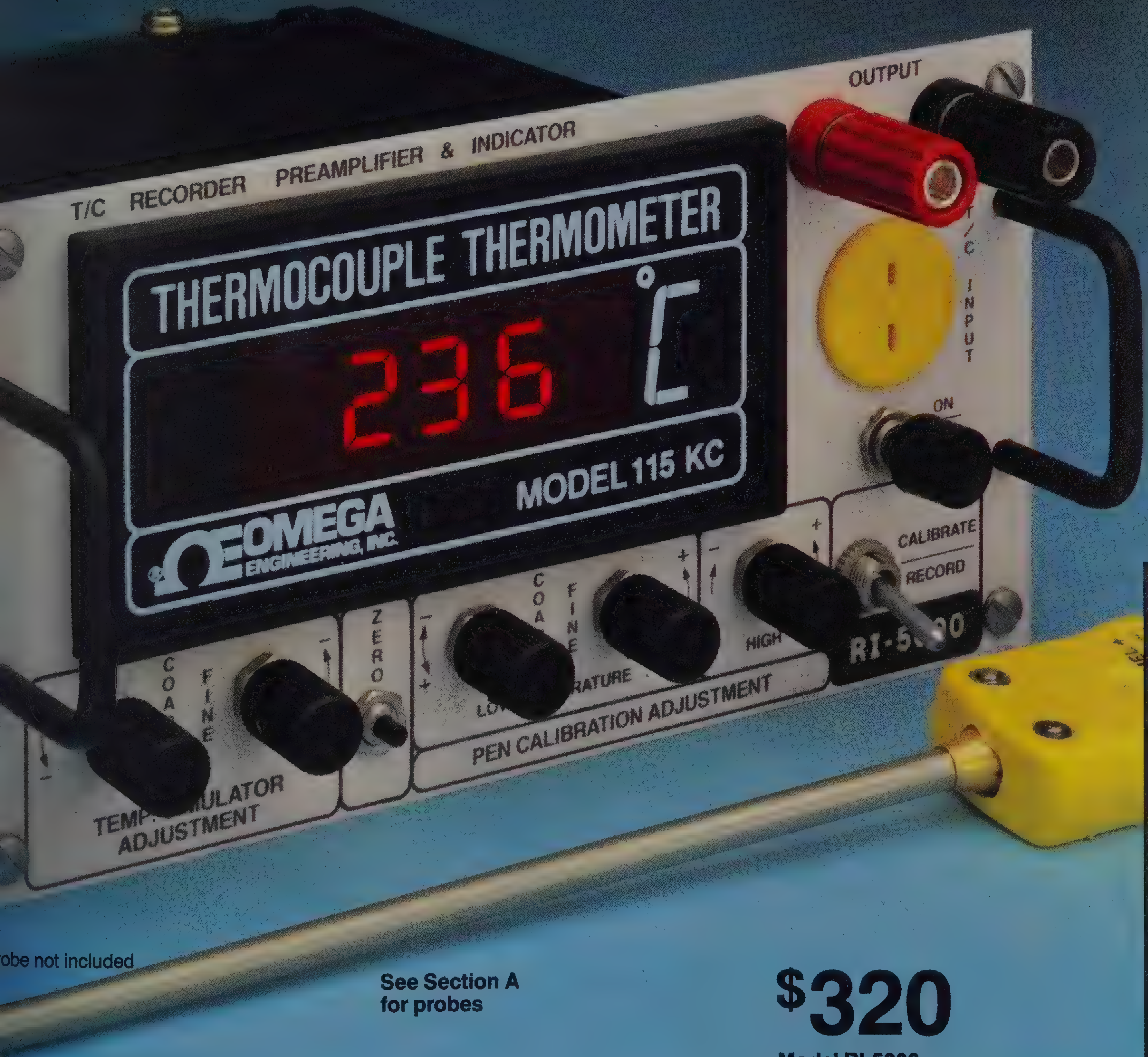
Thermocouple/Recorder Interface

Converts Millivolt Recorders to Linearized Temperature Recorders

- One, Two, or Three Channels to Match Your Recorder
- Bench or Panel Styles
- Linear Temperature Output
- 100% Zero Offset
- Expanded Scales
- Works as a Calibrator too!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236 °C
MODEL 115 KC
OMEGA ENGINEERING, INC.
OUTPUT
T/C INPUT
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CALIBRATE
RECORD
RI-5000
HIGH
LOW
PEN CALIBRATION ADJUSTMENT
ZERO
COARSE
FINE
TEMP. SIMULATOR ADJUSTMENT

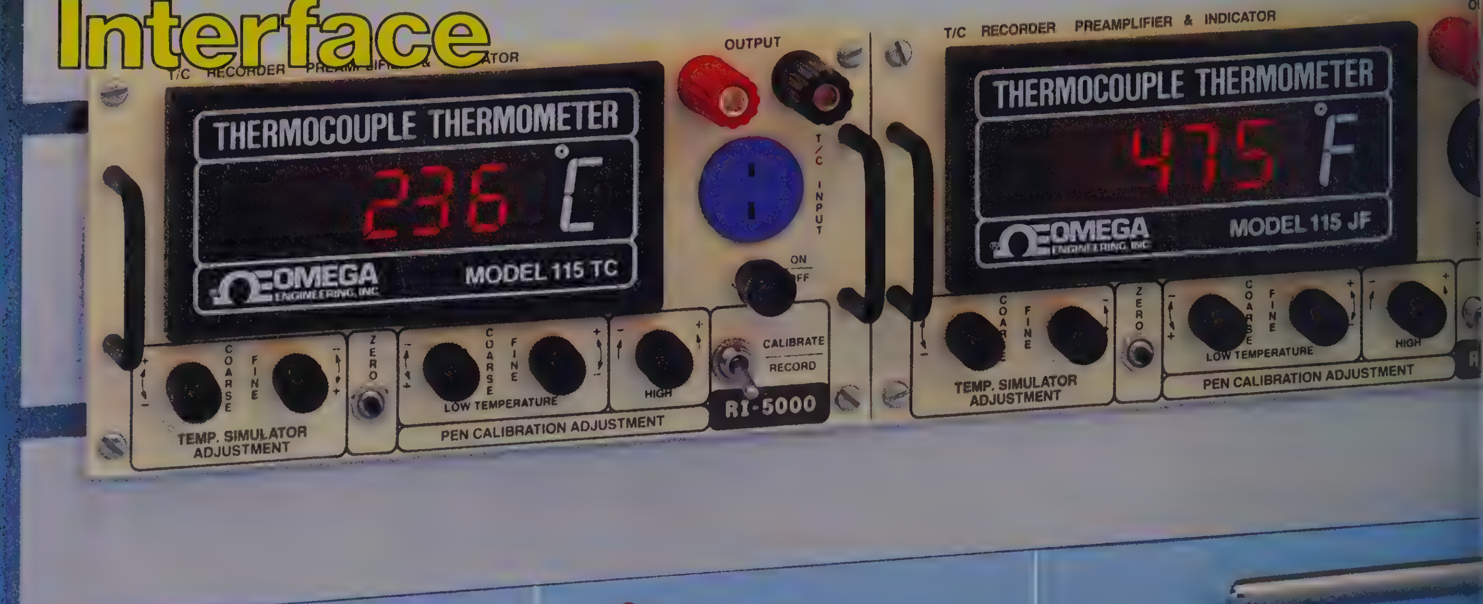
obe not included

See Section A for probes

$320

Model RI-5000
One Channel Rack Mount

Thermocouple/Recorder Interface


T/C RECORDER PREAMPLIFIER & INDICATOR
THERMOCOUPLE THERMOMETER
236 °C
OMEGA ENGINEERING, INC.
MODEL 115 TC
OUTPUT
T/C INPUT
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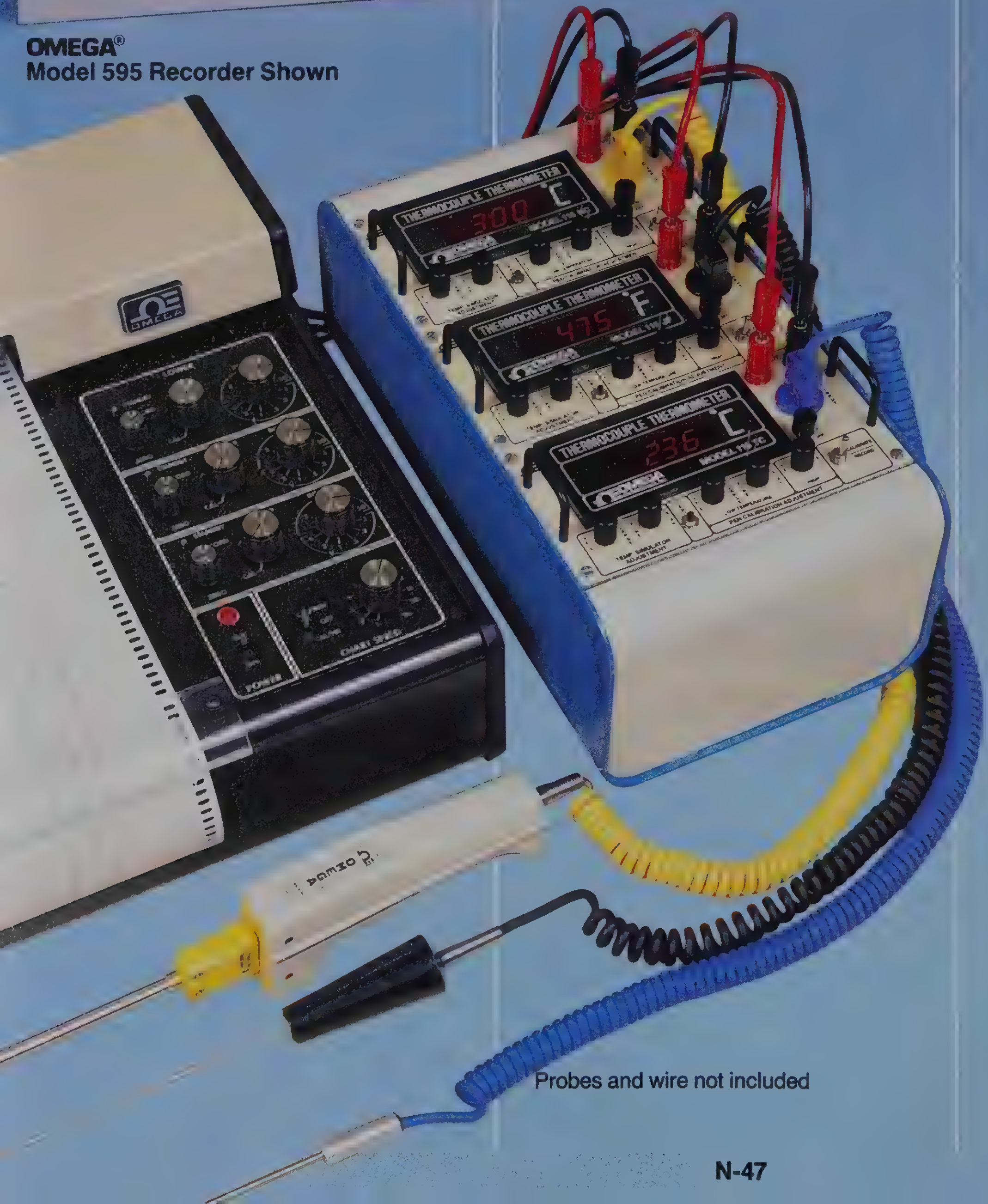
OFF
CALIBRATE
RECORD
RI-5000
COARSE
FINE
ZERO
TEMP. SIMULATOR ADJUSTMENT
LOW TEMPERATURE
HIGH
PEN CALIBRATION ADJUSTMENT
475 °F
MODEL 115 JF

OMEGA®
Model 595 Recorder Shown


OMEGA
THERMOCOUPLE THERMOMETER
300 C
475 F
236 C

Probes and wire not included

Bench Style RI-5100

The RI-5100 Models have a fully enclosed metal case with a hard polyurethane finish to withstand being "knocked" around on a workbench. They are available in ONE, TWO, or THREE channels and are designed to work side-by-side with your recorder to take up a minimum of bench top space.

Mix and Match—put three different calibrations or any combinations in a single box to cover all your measurement/recording needs. No extra bench space is required! Series RI-5100 Thermocouple to Recorder Interfaces are available in J, K, T and E Thermocouple Calibrations. (See Range Table at right for ranges.)

THREE CHANNELS

$1100

Model RI-5103
Bench Style

For Additional Specifications See Recorders, Section N.

RECORDER
PREAMPLIFIER & INDICATOR
OUTPUT
THERMOCOUPLE THERMOMETER
300 °C
OMEGA ENGINEERING, INC.
MODEL 115 KC
ON
COARSE
FINE
ZERO
LOW TEMPERATURE
HIGH
CALIBRATE
RECORD
RI-5000
MP. SIMULATOR ADJUSTMENT
PEN CALIBRATION ADJUSTMENT

Probes and wire not included

Panel Style RI-5000

The RI-5000 Panel is completely modular. It is available with up to three modules fully assembled into a standard 19 inch rack panel, or separately, in a 3 inch by 6 inch panel to fit your custom design.

Mix and Match—put three different calibrations or any combination into a single 19″ panel to cover all your measurement/recording needs. No extra panel space is required! Series RI-5000 Modules are available in J, K, T and E Thermocouple Calibrations. (See Range Table below for ranges.)

THREE CHANNELS

$995

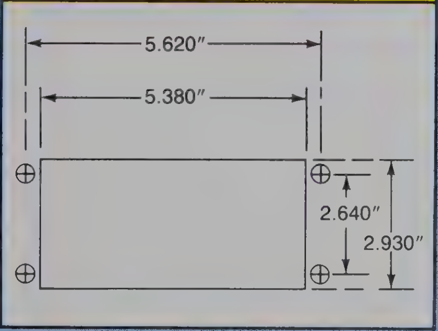
Includes 3 RI-5000 Modules and a 19 inch Panel

ecord Temperature ompensate—Amplify—Linearize—Calibrate

eries RI-5000 instruments make it easy. They take a thermocouple signal, dd cold junction compensation, amplify it, linearize it and output a 1 mV/°C gnal to your recorder.

hese units also have a built-in calibrator to assist in setting up the recorder's cales and a zero offset circuit to set up a precise range. The bipolar output llows you to record positive as well as negative temperatures accurately nd the two styles—Panel and Bench Top—meet most laboratory and dustrial applications.

Cut Out Dimensions RI-5000



ange Table

rder Code	ANSI Type	Temperature Range	Linearized Output	Accuracy	Display Resolution
JC JF	J	−100 to 760°C −100 to 1400°F	1 mV/°C .55 m/°F	±2.5°C ±4°F	1°C 1°F
KC KF	K	−50 to 1200°C −50 to 1999°F	1 mV/°C .55 mV/°F	±3.5°C ±5°F	1°C 1°F
TC TF	T	−100 to 400°C −100 to 750°F	1 mV/°C .55 mV/°F	±2.5°C ±4°F	1°C 1°F
EC EF	E	−50 to 800°C −50 to 1500°F	1 mV/°C .55 mV/°F	±3.5°C ±5°F	1°C 1°F

pecifications

MODEL	HEIGHT	WIDTH	DEPTH	WEIGHT
RI-5000	3″	6″	5.5″*	1.25 lb
RI-5101	6	6.25	5.5	2.75
RI-5102	6	6.25	8.5	4.25
RI-5103	6	6.25	11.5	5.75
9″ Panels	5¼″	19″	.125″	—

I-5000 requires only 4.5 in. clearance behind panel

How To Order *Off-the-Shelf Delivery*

Description	Catalog No.	Price
Rack Mountable Models	RI-5000-[*]	$ 320
19″ Rack Models	RI-5000-[*]-19P1	$ 355
	RI-5000-[*]-[*]-19P2	$ 675
	RI-5000-[*]-[*]-[*]-19P3	$ 995
Bench Top Models		
One Channel	RI-5101-[*]	$ 395
Two Channel	RI-5102-[*]-[*]	$ 750
Three Channel	RI-5103-[*]-[*]-[*]	$1100
Power Options:	Specify after Catalog Number	
	230 V ac (115 V ac, std)	N/C
	50 Hz (60 Hz, std)	N/C

*Insert Order Code From Range Table

Ordering Examples:

RI-5000-JC-KC-19P2	19″ Panel Style with two Model RI-5000s, one Type J and one Type K, fully assembled into a 19″ rack panel.	$675
RI-5103-[JC]-[JC]-[TF]-230	Bench Style Case with three channels, two Type J and one Type T, wired to operate from 230 V ac.	$1100

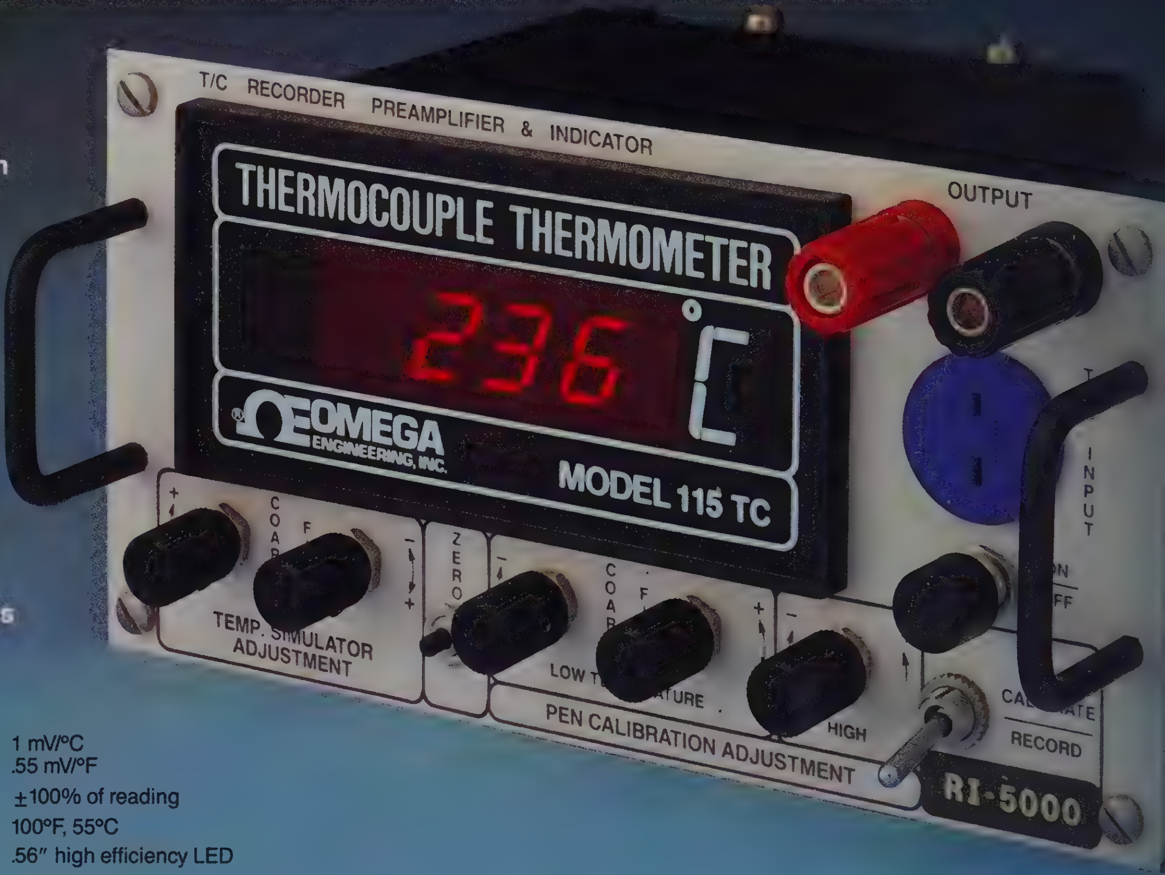
Thermocouple/Recorder Interface

Simplify Recording Temperature and Calibrating your 1, 2, or 3 Channel Recorder

One Channel
$320
Model RI-5000 shown

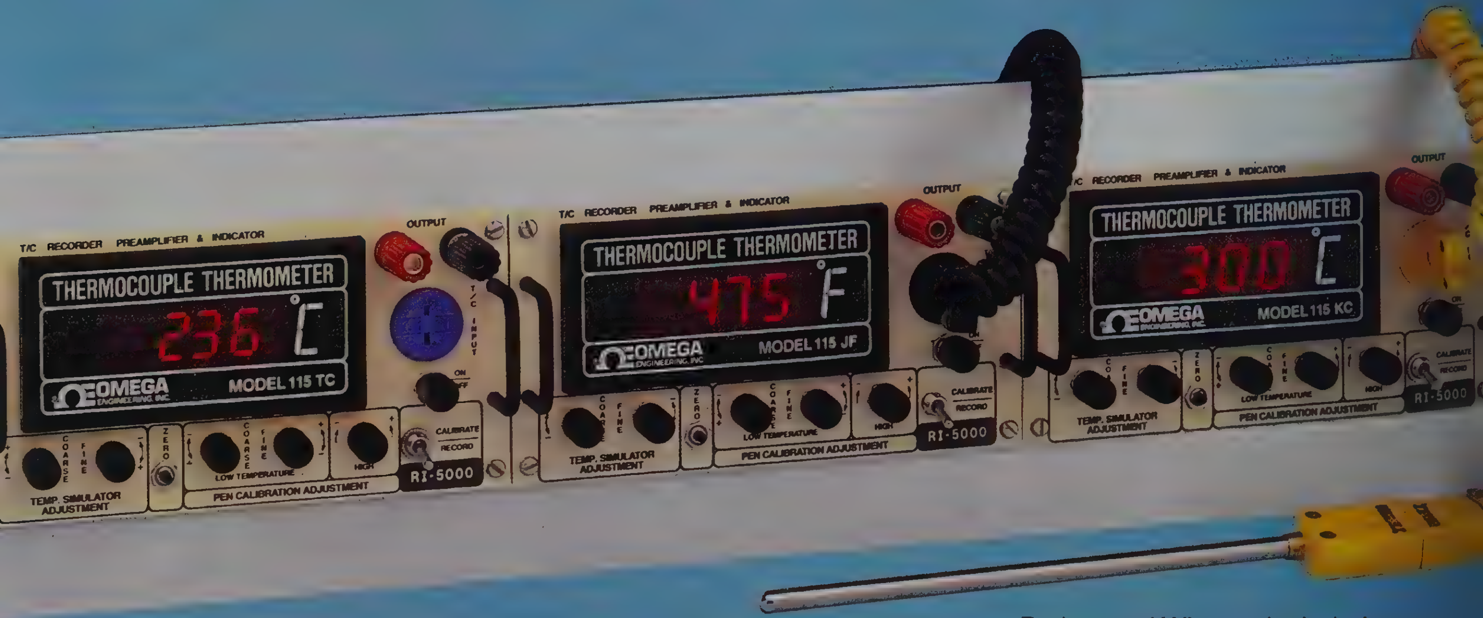
Two Channel
$675
19 in. Rack plus
Two Model RI-5000s

Three Channel
$995
19 in. Rack plus
Three Model RI-5000s

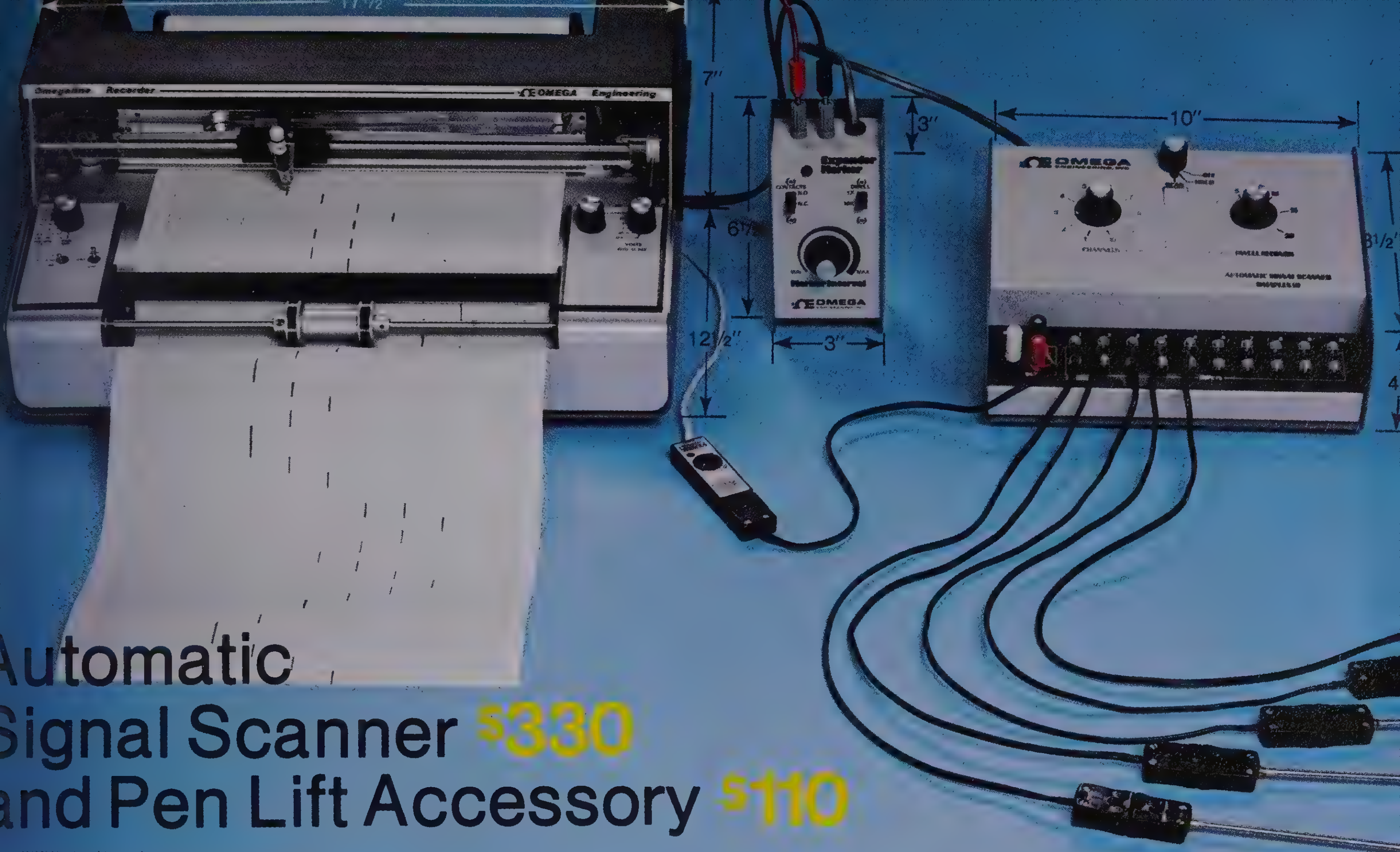

T/C RECORDER PREAMPLIFIER & INDICATOR
THERMOCOUPLE THERMOMETER
236 °C
OMEGA ENGINEERING, INC.
MODEL 115 TC
OUTPUT
INPUT
ON
OFF
COARSE
FINE
ZERO
TEMP. SIMULATOR ADJUSTMENT
LOW TEMPERATURE
HIGH
PEN CALIBRATION ADJUSTMENT
CALIBRATE
RECORD
RI-5000

Specifications

Analog Output:	1 mV/°C .55 mV/°F
Max. Zero Offset:	±100% of reading
Minimum Scale:	100°F, 55°C
Display:	.56″ high efficiency LED
Input Impedance:	> 10 M Ω
Load Impedance:	> 10 k Ω
CMRR:	120dB
CM Voltage:	240 V RMS max
Operating Temperature:	32 to 104°F (0 to 40°C)
Cold Junction Compensation:	.05°C/°C (°F/°F)
Open T/C Indication:	Trace goes to high end of scale
Power Per Channel:	1.9 Watt


THERMOCOUPLE THERMOMETER
236 °C
MODEL 115 TC
475 °F
MODEL 115 JF
300 °C
MODEL 115 KC
RI-5000

Probes and Wire not included


7"
3"
10"
6⅞"
12½"
3"
3½"
4
Omegaline Recorder
OMEGA Engineering
Expander Marker
Marker Interval
OMEGA
AUTOMATIC SIGNAL SCANNER
DATAPLEX 10

Automatic Signal Scanner $330 and Pen Lift Accessory $110

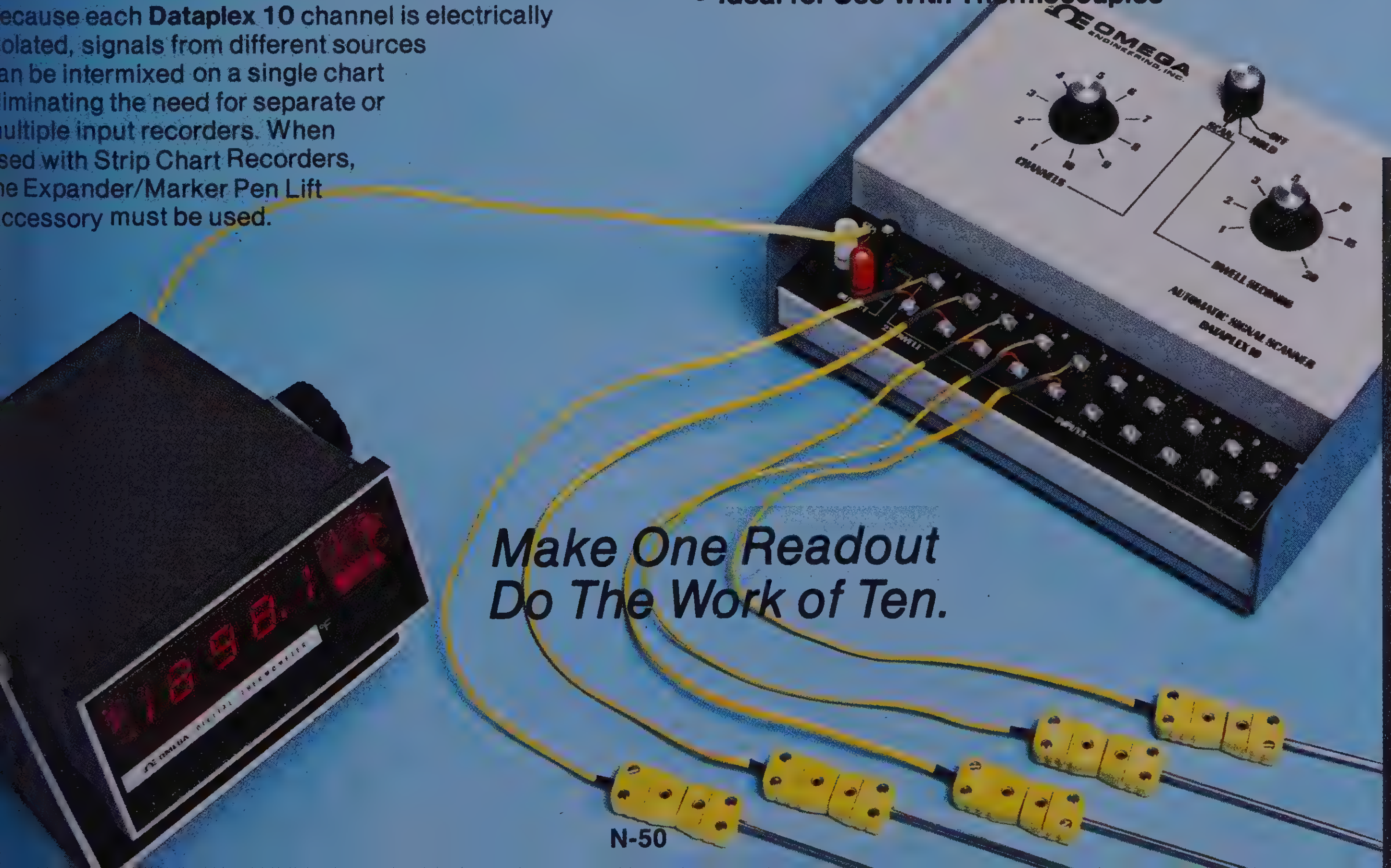
or Thermometry

he **Dataplex 10** is a signal multiplexer with ten dependent input terminals. With it, up to ten different formation-carrying signals can be directed in sequence a signal readout device . . . recorder*, meter, printer, scilloscope, etc.

trip Chart Recorders must be equipped with electric pen lifts.

ecause each **Dataplex 10** channel is electrically olated, signals from different sources an be intermixed on a single chart liminating the need for separate or ultiple input recorders. When sed with Strip Chart Recorders, he Expander/Marker Pen Lift ccessory must be used.

- **10 Separate Input Channels**
- **Variable Dwell Time**
- **Channel Hold Feature**
- **Channels Scanned Selection**
- **Low Voltage Operation for Field Use**
- **Ideal for Use With Thermocouples**


OMEGA ENGINEERING, INC.
CHANNELS
SCAN HOLD OFF
DWELL SECONDS
AUTOMATIC SIGNAL SCANNER
DATAPLEX 10
INPUTS
OMEGA DIGITAL THERMOMETER
Make One Readout
Do The Work of Ten.

Automatic Signal Scanner for Thermometry

$330

SCAN HOLD OFF
CHANNELS
DWELL SECONDS
Automatic Signal Scanner
OUTPUT
2X DWELL
INPUTS

Description

The **Dataplex 10** has ten pairs of screw terminals for signal input conveniently located on the front panel. As each pair is switched in turn to a pair of 5-way binding post output connections an LED visually indicates the active channel.

Front panel controls allow the user to select the number of channels scanned; to select the dwell time; and, if desired, to hold any given channel continuously connected to the output.

The dwell timing circuit automatically doubles the dwell time in channel one to allow easy identification of this channel in long chart recordings.

Signal switching is accomplished with break-before-make reed relays. The use of reeds eliminates impedance matching problems — the signal "sees" the input impedance of the readout device used. Use of the **Dataplex** does not modify the input signal.

Each **Dataplex** input is completely isolated and independent from the others.

For use with Strip Chart Recorders, the recorder must be equipped with an "electric pen lift", and the **Expander/Marker Pen Lift** accessory must be used.

Modification for Field Use:

The **Dataplex 10** normally operates from a cord mounted low voltage supply (type used for hand calculators) but a simple internal connection will allow operation from a 12 volt battery supply. This feature is particularly useful in the collection of long term environmental data.

Specifications:

Channels — 10

Switching — Double pole reed relays (break-before-make)

Typical Contact Specifications —

1. Resistance — 0.25 ohms/pole initial
2. Bounce — less than 200 microseconds
3. Offset — less than 20 microvolts (scanning)

DWELL TIME — Continuously variable 1-20 seconds (1-200 seconds with Expander/Marker Accessory)

Inputs — 10 pair of screw terminals

Output — Three 5-way binding posts (2 signal; 1 guard)

Maximum Signal — 30 volts (10 watts maximum) (absolute max. 0.5 amps resistive)

Operating Voltage — 100-125 volts 60Hz (220v 50Hz Special Order $360.00 (internal connection allows operation from 12v DC (13±10%) for field use)

Also Available:

Expander/Marker and Pen Lift Accessory

This accessory allows a 10 fold expansion of the basic 1-20 second dwell time per channel making the adjustable range effectively 1-200 seconds.

For use with Strip Chart Recorders, the recorder must be equipped with an "electric pen lift", and this accessory must be used.

In addition the plug-in module provides channel marking and identification with variable time signal blanking or shorting. The accessory can also be used to activate the pen lift option on recorders so equipped.

The Expander/Marker module plugs into an existing jack on the **Dataplex 10** and is powered from it. The accessory may be added at any time.

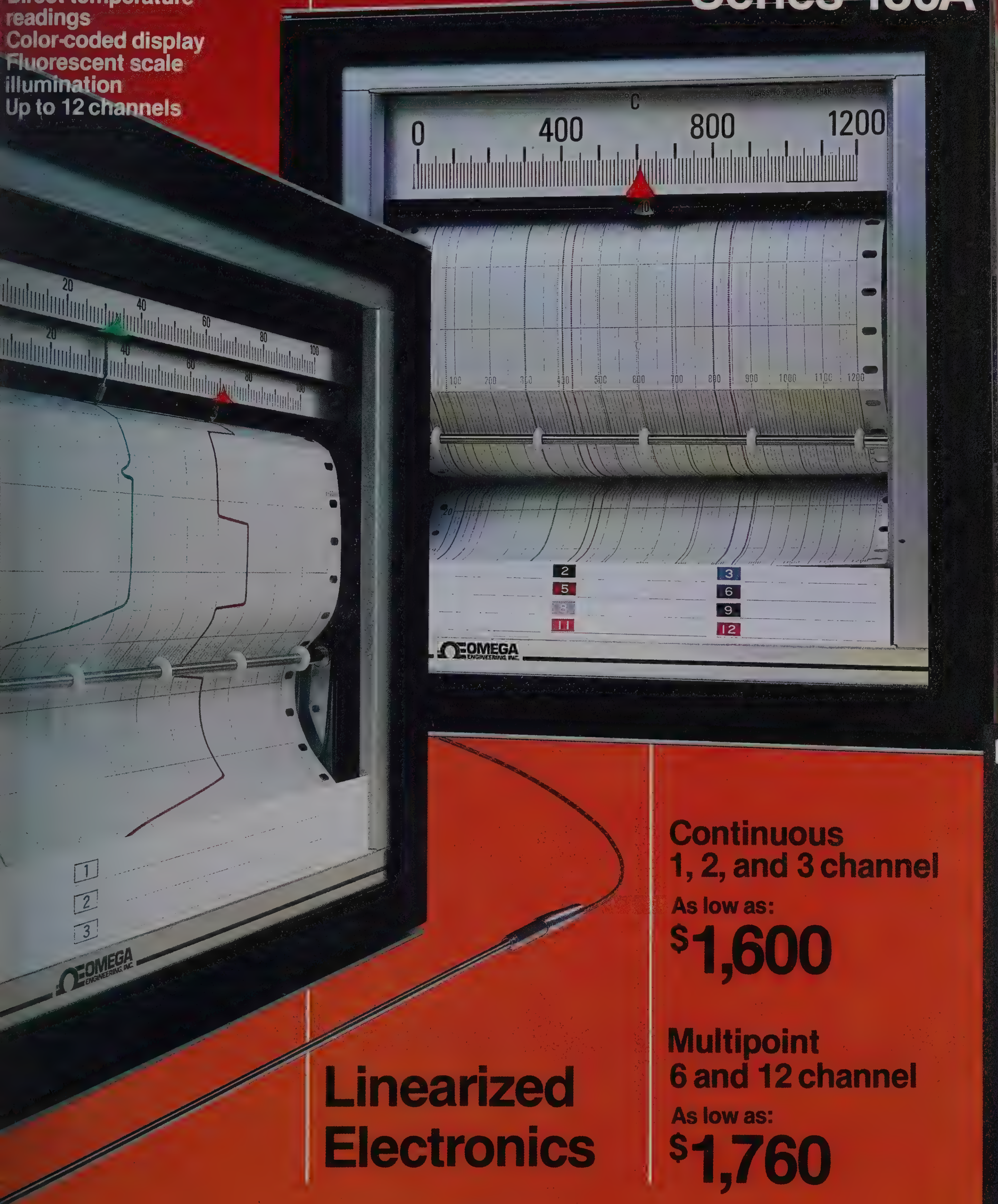
$110

Marker Expander
CONTACTS
NO
NC
DWELL
1X
10X
MIN.
MAX.
Marker Interval

Precision Temperature Process Recorders

Series 180A

- Thermocouple inputs: Types J, K, T, E, R, and millivolts
- Direct temperature readings
- Color-coded display
- Fluorescent scale illumination
- Up to 12 channels



°C
0
400
800
1200
2
3
5
6
8
9
11
12
1
2
3
OMEGA ENGINEERING, INC.
OMEGA ENGINEERING, INC.

Continuous
1, 2, and 3 channel

As low as:

$1,600

Multipoint
6 and 12 channel

As low as:

$1,760

Linearized Electronics

Precision Temperature Process Recorders

NEW!

Series 180A

Linearized Electronics

Continuous
1, 2, and 3 channel

As low as:

$1,600

Multipoint
6 and 12 channel

As low as:

$1,760

Fluorescent chart illumination

Rugged Modular Construction

Switch selectable: 4 speeds chart drive standard 12.5, 25, 50 and 100 mm/hr.

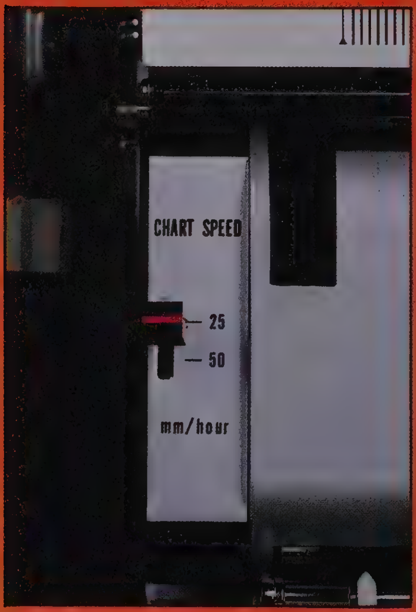
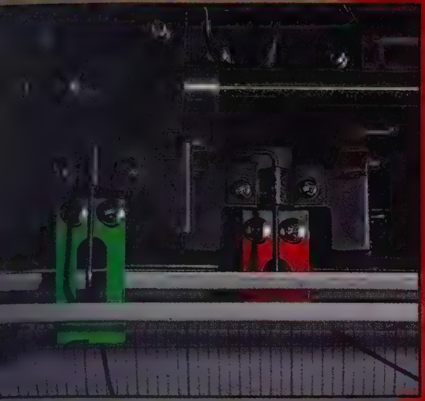


CHART SPEED
25
50
mm/hour

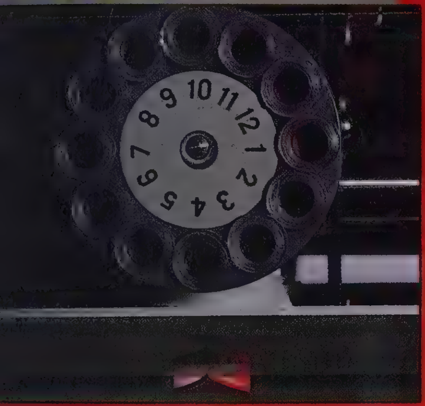
Easy-to-read scales

°C
0
400
800
1200

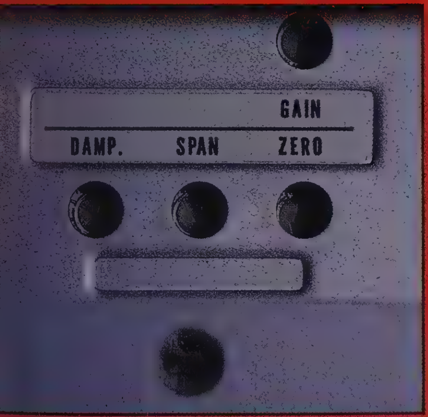
1, or 3 PEN CONTINUOUS
pphire tipped pens for long life



2 MULTIPOINT color-coded dot
rinting system



asy access to zero, span and
ain adjustments



ront panel control

ON
INDICATE
ON
RECORD

Continuous 1, 2, and 3 channels

Same quality features as the Multipoint plus sapphire tipped pens for long life.

OMEGA Series 180A Continuous Temperature Recorders are high quality precision instruments available with 1, 2, or 3 independent inputs. Their rugged design and long-life features make them excellent choices for industrial and scientific applications. Fluorescent light illuminates the easy-to-read scale and chart paper. A 2-speed chart drive (25 and 50 mm/hr) is switch selectable; no changing of gear racks is required.

All OMEGA Series 180A continuous recorders have sapphire tipped pens for long life and ease of maintenance. A large ink reservoir provides days of recording without adding ink. Standard recorders can be used to measure temperature and millivolts. Thermocouple models feature cold junction compensation and direct-temperature reading chart paper.

Without options, the Series 180A recorders are available "Off-The-Shelf" and are shipped calibrated with a complete recording kit. Just connect your thermocouple to the rear panel and start recording.

Accessories

Keep Extra Pens and Paper on Hand

Model	Catalog No.	Description	Price
	180-PEN	Pen Tip for Continuous Recorders	$12
Continuous		Ink for Continuous Recorders	
1, 2, 3	180-INK-01	Red, box of 3 bottles	12
	180-INK-02	Blue, box of 3 bottles	12
	180-INK-03	Green, box of 3 bottles	12

Multipoint 6 and 12 channel

- **Thermocouple inputs: J, K, T, E, R, and mV**
- **Direct temperature reading**
- **Large, easy-to-read scale pointer**
- **Switch selectable chart speeds**
- **Cold junction compensated**
- **Fluorescent chart illumination**
- **Protective cover glass**
- **Rugged, modular design**
- **Color-coded channels for easy identification**

OMEGA Series 180A Multipoint Temperature Recorders have a unique color-coded recording system that makes each point easy-to-read. Their custom design features and low per-channel cost make them the economical choice for processes with up to 12 temperature sensors. For larger systems several multipoint units can be the best value.

A fluorescent lamp illuminates the large scale and easy-to-read chart, plus the 12 individual colors on the chart which clearly identify each input. Long term drift and process variations are quickly scanned by just flipping through the Z-fold chart paper. A protective glass door keeps dirt and contaminants out and precision and long life in. All controls have been designed for easy use and are readily accessible. The two speed chart drive (25 and 50 mm/hr) is switch selectable; no gears to be changed or get lost. Separate switches also control the chart and pen systems for added versatility.

Almost any thermocouple can be used. Types J, K, T, E, and R cover the broadest range for process and environmental temperature requirements. Each recorder can be configured to match your system. Just select a thermocouple type and range required. Cold junction compensation and linearized electronics provide direct readouts of your process temperatures. No special scales or conversion tables are required. Quick connect terminals are standard for easy hookup and all accessories required to start recording are supplied.

Standard models and ranges are available "Off-The-Shelf" for immediate delivery.

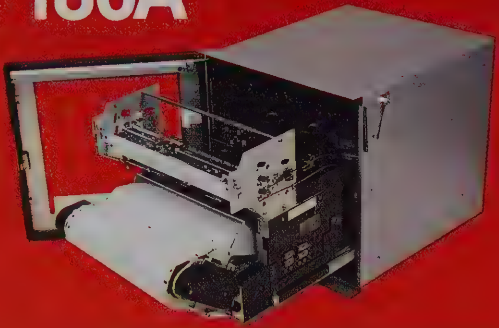
Accessories

Keep Extra Pens and Paper on Hand.

Model	Catalog No.	Description	Price
	Ink Pad Wheel For Multipoint Recorders.		
Multipoint 6/12	180-PAD-06	6-Channel Pad	$ 7.50
	180-PAD-12	12-Channel Pad	9.00
	Ink For Multipoint Recorders.		
	·180-INK-06	6-Channel, box of 6 colors	10.20
	180-INK-12	12-Channel, box of 12 colors	20.40

Precision Linear Temperature Process Recorders

Series 180A



Range Table

Input Type	Range	Range Code
K	0 to 1000 °F 0 to 1500 °F 0 to 2400 °F 0 to 800 °C 0 to 1000 °C	K-0/1000F K-0/1500F K-0/2400F K-0/800C K-0/1000C
J	0 to 500 °F 0 to 800 °F 0 to 1000 °F 0 to 400 °C	J-0/500F J-0/800F J-0/1000F J-0/400C
T	–100 to 400°F 0 to 200°C	T-100/400F T-0/200C
E	0 to 1000 °F 0 to 500 °C	E-0/1000F E-0/500C
R	0 to 1600 °C	R-0/1600C
mV	0 to 100 mV	mV-0/100

Special ranges available. Consult Sales Department.

How To Order

Model	Description	Cat. No.	Price
Continuous 1, 2, 3	1-Channel Continuous Recorder mV input Thermocouple input	**180A-01-[*]**	 **$1,600** **1,640**
	2-Channel Continuous Recorder 2 mV inputs 2 Thermocouple inputs	**180A-02-[*]**	 **2,470** **2,550**
	3-Channel Continuous Recorder 3 mV inputs 3 Thermocouple inputs	**180A-03-[*]**	 **3,400** **3,520**

[*] = Insert Range Code from Range Table.
Keep Extra Pens and Paper on Hand.

Specifications

Measuring system: Potentiometer
Input span (minimum):
mV: 3mV
Thermocouple: Types K, J, T, E: 200 °C
Type R: 450 °C
Recording mode: 1, 2 or 3 pen continuous writing (removable cartridge pen tip) or multipoint dotting with 6 or 12 points. (Ink pad dotting with a different color ink at each point.)
Balancing speed: 2.5 sec. (50 Hz), 2.1 sec. (60 Hz)
Chart paper: Z-fold, 180 mm cal. width, 20 m long
Dotting interval: 5 sec. (60 Hz), 6 sec. (50 Hz)
Accuracy: ± 0.5% of full scale
Dead band: 0.1% of full scale
Chart speed: 25 or 50 mm/hr., 2-position switch selectable (other chart speeds available)
Ambient temperature: – 10 to 50 °C (14 to 122 °F)
Case: Steel plated with die cast aluminum door
Illumination: Fluorescent lamp
Power requirements
Power supply: 115 V ac ± 10%, 50 or 60 Hz
Input impedance: 100 k Ω
Source resistance: Up to 10 k Ω
Input isolation: Measuring terminals to ground terminal: 20 M Ω at 50 V dc. Power supply to ground terminal: 20 M Ω at 100 V dc
Dielectric strength: Measuring terminals to ground terminal: 500 V ac, 1 minute. Power terminal to ground terminal: 1000 V ac 1 minute.

Accessories supplied
Chart paper: 1 package
Fuse: 1 A, 2 ea.
Mounting bracket: 1 set ea. per recorder
Cartridge pen tip: 1, 2 or 3 per recorder, depending upon mode
Ink pad print wheel: 1 per recorder (multipoint)

Options

	Options	Price
01	Carrying Handle and Feet	$ 40
02	DC Power Supply, specify 12 or 24 V dc	400
05	Analog Output, 0 to 1 V	240
06	Analog Output, 0 to 10 mV	240
19	Pen Event Marker (one pen models only)	400
66	Six-speed Chart Drive 12.5 to 750 mm/hr.	350
36	High and Low Limit Alarms (multipoint 6/12 models only)	250

Paper

Catalog Number 180A-CP-[+]

Z-fold strip chart, 180 mm wide, 20 m long.

	Price
Standard Ranges	
Package of 1	$ 12
Case of 15	175
Non-Standard Ranges	
Case of 15	175

[+] Specify Numeric Range from Range Code

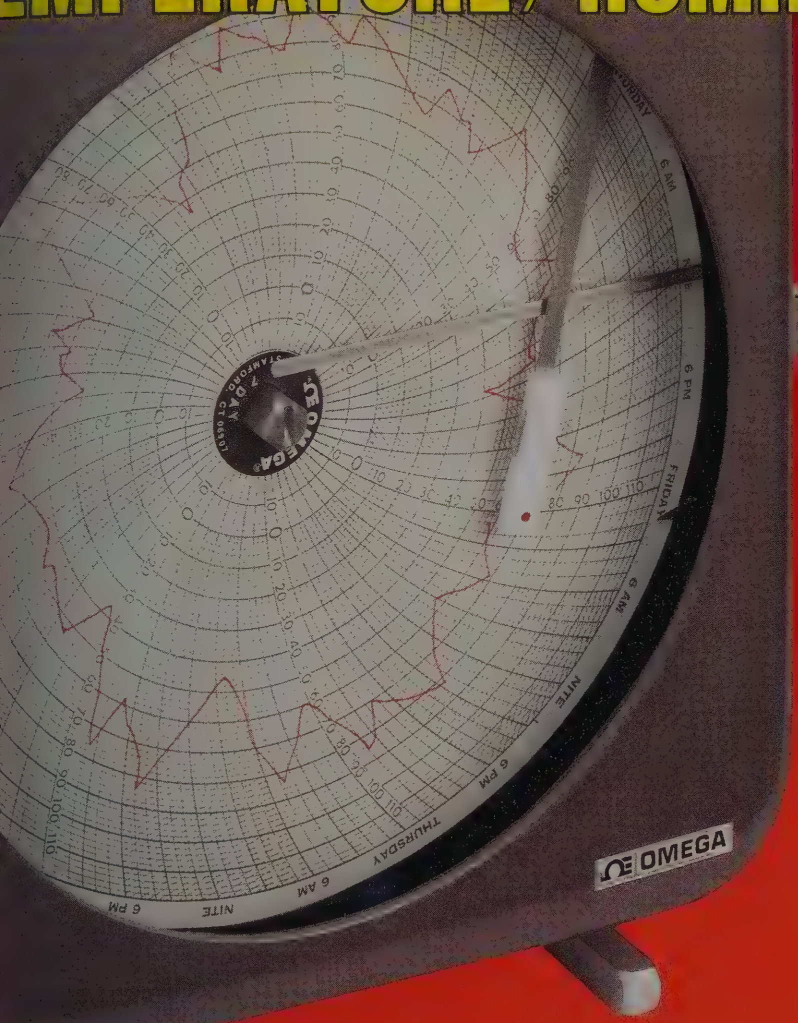
[*] = Insert Range Code from Range Table

How To Order

Model	Description	Cat. No.	Price
Multipoint 6/12	6-Channel Multipoint mV input Thermocouple input	**180A-06-[*]**	**$1,760** **1,800**
	12-Channel Multipoint mV input Thermocouple input	**180A-12-[*]**	 **2,010** **2,050**

[*] = Insert Range Code from Range Table.
Example: 180A-06-K-01000F

-400 SERIES SELF CONTAINED
EMPERATURE / HUMIDITY RECORDERS



OMEGA CT-400 SERIES Recorders are perfect to monitor temperature or temperature and humidity in refrigerated, air conditioned, or climate controlled areas. Fully portable for moving vehicles or remote locations. No power required—ideal for computer rooms or food storage areas. Models for one day or seven days using 4″ or 8″ charts.

TEMPERATURE MODELS
CT-414 and CT-418

- Temperature Ranges −20° to +120°F
- Felt Tip Pens—No Mess
- Reliable Battery Drives
- Compact Size: 5¼ × 5¼ or 9½ × 9½

CT-414 4″ Chart	CT-418 8″ Chart
$150	**$250**

Price includes box of 100 charts, pen, and battery

OW TO ORDER:
ecify Model No.

nperature Models

Model No.[1]	Range	Price
414- 30F-[•]	−15° to + 30°F	$150
414- 45F-[•]	0° to + 45°F	
414- 60F-[•]	0° to + 60°F	
414- 90F-[•]	+45° to + 90°F	
414-100F-[•]	0° to +100°F	
414-120A-[•]	−20° to +120°F	
414-120B-[•]	+75° to +120°F	
418- 60F-[•]	0° to + 60°F	$250[2]
418-100F-[•]	0° to +100°F	
418-120F-[•]	−20° to +120°F	

ert 1 or 7 for one day or seven day drive.

Battery drive is standard. If heavy duty spring drive is equired, add suffix SPRING to model number. CT-418 with heavy duty spring drive is $285.

lacement Charts	CT-414 Series CT-418 Series	$7 $9

rder box of 100 charts, add CHART to recorder no. ART and recorder ranges must match.)

mple: CT-414-30F-1-CHART
Box of 100 4″ replacement charts for CT-414 with range of −15° to 30°F and time scale of one day.

a Pens (fits all models)	CT-400-PEN-RED CT-400-PEN-BLUE	$5 $5
Batteries	MN-1500-2 two AA alkaline batteries One battery required to drive unit.	$1/pr.

NEW!

- Rugged Heavy Duty Case
- Accurate
- Battery Operated

CT-400 SERIES SELF CONTAINED
TEMPERATURE/HUMIDITY RECORDE

HUMIDITY AND TEMPERATURE MODELS

CT-424 and CT-428

One Chart/Two Functions

Perfect for Computer Rooms—Textile and Paper Mills—Wherever Temperature and Humidity must be monitored.

- 4" or 8" Charts
- 1 Day or 7 Day Models
- −20° to +120°F Temperature Ranges
- 0% to 100% Relative Humidity
- Rugged Metal Case
- Battery Chart Drive

OMEGA
Blue Relative Humidity
Red Temperature
OMEGA

CT-424 4" Chart	CT-428 8" Chart
$425	$525

Price includes box of 100 charts, pen, and battery

HOW TO ORDER:

Specify Model No.

Temperature and Humidity Models

Chart	Model No.	Temperature Range	Humidity Range	Price
4"	CT-424-1	0 to 100°F	0-100% R.H.	$425
4"	CT-424-7	0 to 100°F	0-100% R.H.	
8"	CT-428-1	−20 to 120°F	0-100% R.H.	$525
8"	CT-428-7	−20 to 120°F	0-100% R.H.	

Replacement Charts—Box of 100
Models **CT-424** and **CT-428** use the standard 0 to 100°F replacement charts for Model **CT-414** and −20° to 120°F replacement charts for Model **CT-418**

Recorder No.	Chart No.	
CT-424-1	CT-414-100F-1-CHART	$7
CT-424-7	CT-414-100F-7-CHART	$7
CT-428-1	CT-418-120F-1-CHART	$9
CT-428-7	CT-418-120F-7-CHART	$9

Extra Pens (fits all models)

CT-400-PEN-RED	$5
CT-400-PEN-RED	$5

Extra Batteries MN-1500-2	Pair of spare AA alkaline batteries. One battery required to drive unit.	$1

Specifications for All Mode

Temperature: All Ranges ± 2% F.S.
Relative Humidity: 15% to 90% ± 3% F.S.

	Size			Weight	
	H	W	D		
CT-414	5½"	5½"	2¾"	1¼ lbs. 1¼ lbs.	Ba Sprin
CT-418	9½"	9½"	4"	5¼ lbs. 5¼ lbs.	Ba Sprin
CT-424	6"	6"	4"	3 lbs.	Ba
CT-428	9½"	9½"	4"	5½ lbs.	Ba

Drive: 1 day or 7 day battery operated quartz movement, one year battery life.
Spring drive optional on **CT-414** and **CT-418**

Mounting: Portable or wall mountable

NEW!

CHART-TEMP™ Temperature Recorders

Document Temperature During Shipment or Storage

Model CT-380

- Trucks
- Trains
- Ships
- Airplanes
- Refrigerators
- Freezers
- Environmental Studies

Portable
Records up to 32 days!
No Power
No Batteries
No Probes
No Ink
No Problems!

- **Rugged—Heavy Duty Case**
- **3 Temperature Ranges to Monitor**
  Freezers
  Refrigeration
  The Environment
- **Maximum/Minimum Deviation Indicators**
- **Sealable Latch**
- **Selectable Chart Speed**
  32 day record
  16 day record
  8 day record

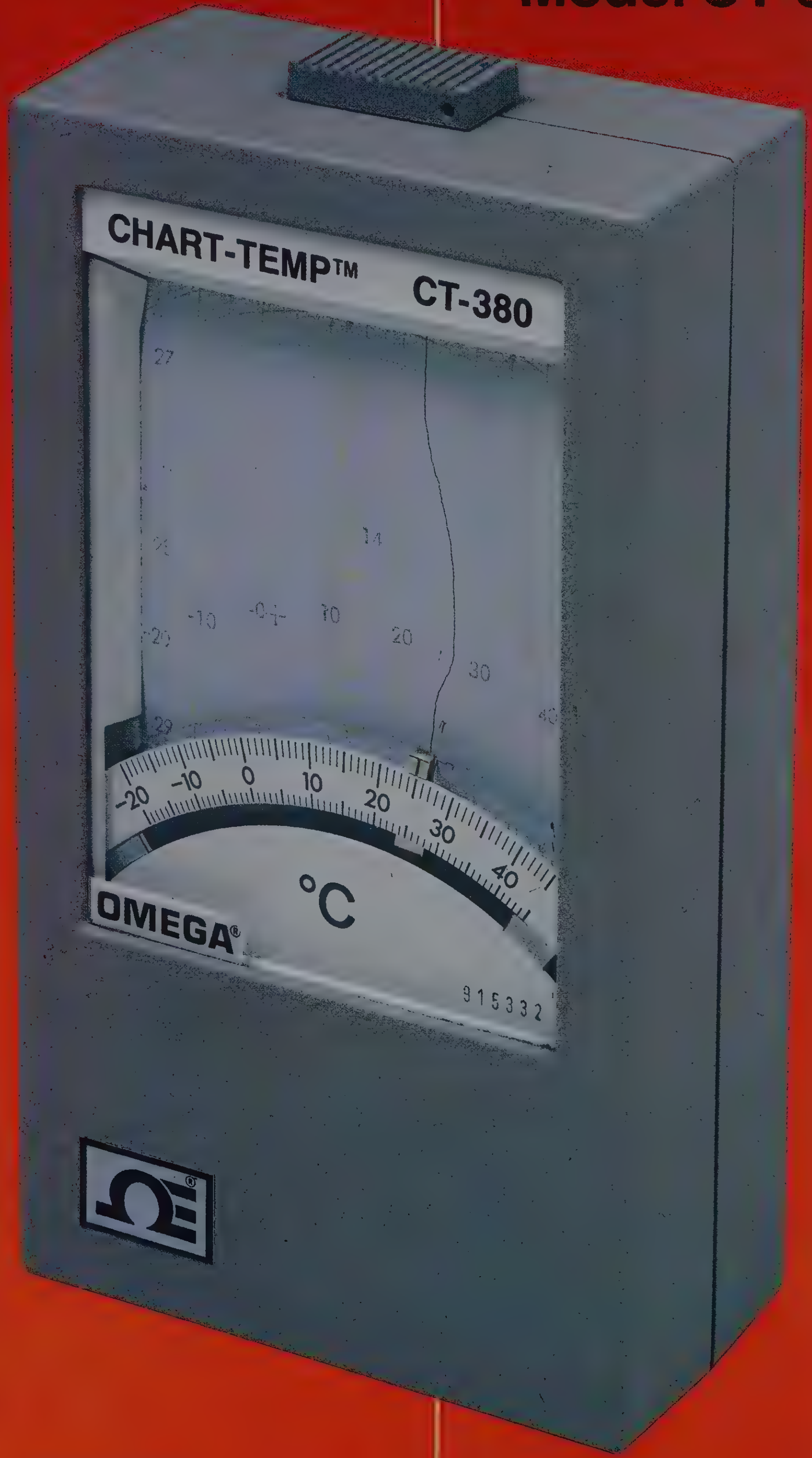
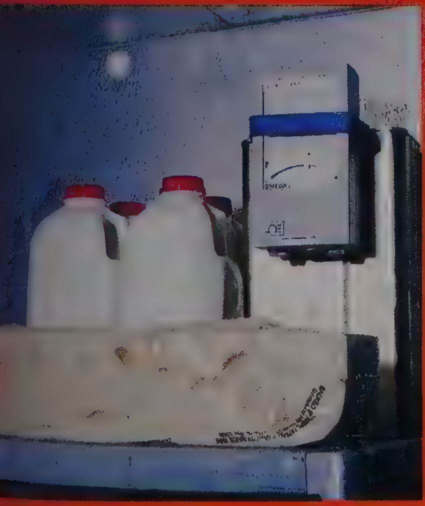


CHART-TEMP™
CT-380
27
14
-10
0
10
20
30
-20
-10
0
10
20
30
40
°C
OMEGA®
915332



Model CT-380
$295

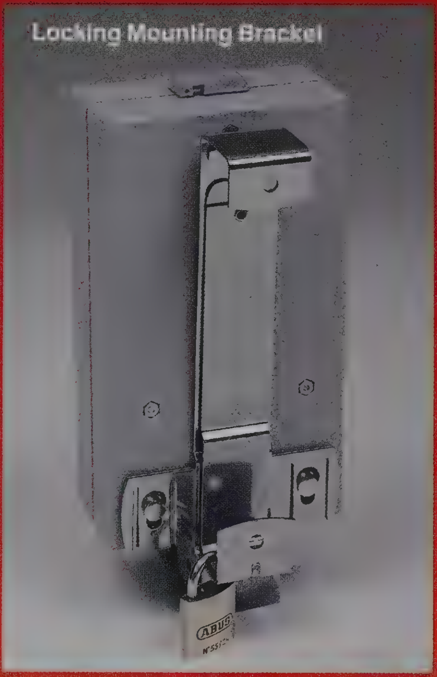
Rugged—Compact—Accurate

CHART-TEMP™ Temperature Recorders

Model CT-380

ACCESSORIES

Snap-on Mounting Bracket


Locking Mounting Bracket
ABUS

Leather Carrying Case

CT-380-SB	Snap-on mounting bracket. Elastic strap provides easy release.	**$25**
CT-380-LB	Locking bracket with provision for padlock to secure recorder.	**$25**
SC-380	Leather carrying case includes strap and paper compartment.	**$26**
CT-380-RP*	Replacement paper. Pack of 10 rolls.	**$30**

* Specify range code 25, 45 or 65.

Replacement Paper

SPECIFICATIONS

Temperature Range:

Range Code	Range
65	0° to 65°C (32° to 149°F)
45	–20° to 45°C (–4° to 113°F)
25	–40° to 25°C (–40° to 77°F)

Chart Speed:	Adjustable 1, 2, or 4 mm/hr.
Accuracy:	Temperature ±1°C Time ±1%
Scale Width:	68 mm (2.7″)
Response Time:	15 minutes for 50% step in still air
Dimensions:	H: 165 mm (6.5″); W: 92 mm (3.6″); D: 46 mm (1.8″)
Weight:	1 kg (2.2 lb)

HOW TO ORDER

3 Ranges In Stock For Immediate Delivery

Model	Range	
CT-380-65	0° to +65°C	**$295**
CT-380-45	–20° to +45°C	
CT-380-25	–40° to +25°C	

CHART-TEMP™ Temperature Recorders

OMEGA
ENGINEERING, INC.
RANGE -40°F to 160°F
-40°C to 70°C
Order charts by
Temperature °F or °C
and Time Range

OMEGA
ENGINEERING, INC.
RANGE -40°F to 160°F
-40°C to 70°C
Order charts by
Temperature °F or °C
and Time Range

All Models
$169

Replacement Charts: $7

Features:

- **Fahrenheit and Celsius Models Available For Temperatures to 220°F and 70°C.**
- **24 hour or 7 Day, Spring-wound Chart Drives Available.**
- **Dry Stylus, Non-ink Etched Recording.**
- **Low Cost, 3-⅝" Diameter Pressure-sensitive Charts.**
- **2% of Full Scale Accuracy.**
- **Use in Any Position**

OMEGA CHART-TEMP™ recorders are dry stylus, spring-wound, clock-driven circular chart recorders which never require ink or any type of electric power. Simply rewind the chart drive when you replace the chart, either 24-hour or 7-day.

OMEGA CHART-TEMP™ recorders are excellent instruments for recording temperatures inside buildings, refrigerators, shipping containers, drying sheds, and control rooms. Models are available with ranges from –40°F to +220°F and –40°C to +70°C.

The stainless steel dry stylus never needs sharpening. A permanent record is etched on the recorder's pressure sensitive chart paper. The high quality recorder movement will operate in extreme temperatures from –70°F to +240°F (–56°C to 115°C) when conditions exceed the range of the recorder.

Each OMEGA CHART-TEMP™ recorder is supplied with a box of 100 charts.

Dimensions:
Diameter: 3.94" (100.08 mm)
Height: 3.25" (82.55 mm)
Weight: 14 oz (397.7 grams)

How To Order:

Select Time Span and Temperature Range
Specify Catalog Number

Time Span	Temperature Range	Catalog No.	Extra Box of 100 charts $7
24 Hour	0° to 100°F	CT-100F-1	1-100F
	20° to 120°F	CT-120F-1	1-120F
	–40° to 160°F	CT-160F-1	1-160F
	20° to 220°F	CT-220F-1	1-220F
7 Day	0° to 100°F	CT-100F-7	7-100F
	20° to 120°F	CT-120F-7	7-120F
	–40° to 160°F	CT-160F-7	7-160F
	20° to 220°F	CT-220F-7	7-220F
	– 5° to 50°C	CT- 50C-7	7-50C
	–40° to 70°C	CT- 70C-7	7-70C

For vertical mounting, order mounting bracket.

Cat. No. CT-MB

Price: $10.15

For added versatility, you can change the range of your CHART-TEMP™ by ordering additional cover glass and bimetallic assemblies and matching chart paper.

CT-CGBA-(range)

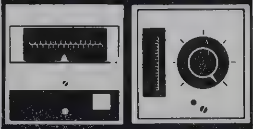
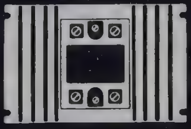
Price: $33.25

PROCESS
SETPOINT
OUTPUTS
PARAMETERS
ON
OFF
OMEGA
6400
300
100
500
0
600
TYPE J
BAND RES
TIME
OMEGA
1000
500
1500
0
OMEGA
SET 1
SET 2
READ
RTD
99.9
°F
OMEGA
1000
1500
2500
0
600
400
800
200
°C
OMEGA ENG.
STAMFORD
OMEGA
OMEGA
SOLID STATE RELAY

OMEGA ENGINEERING, INC
OMEGA ENGINEERING, INC
450
OMEGA ENGINEERING, INC
OMEGA ENGINEERING, INC
°F

P

Solid State Temperature Controllers and High Power Switching Devices

NEW Series CN2010 Ramp/Soak Programmable Controller		P-3
Series 4000 Thermocouple and RTD Controllers		P-7
NEW Series 6000 Microprocessor based Temperature Controllers		P-12
Series 920 Digital, Analog and Non-indicating Models		P-18
NEW Series CN25 Multifunction Process Controllers		P-24
NEW Series CN300 Economical "Panel Meter" Controllers		P-28
Series 6100 1/16 DIN Controllers		P-30
Series 1400, 1500, 1600 Series 20 Family of Controllers		P-33
Series 49, 50, 149 Analog and Digital Controllers		P-42
Series 6400 Laboratory Bench Top Controller		P-53
NEW Solid State and Mechanical Relays and Temperature Alarms		P-57

Programmable Temperature Controller Model CN-2010

NEW!

$595
With Ramp and Soak
Plus Two Alarms

ALM 12
PV
947
TUN
OUT 12
SP 947 F
REM
MAN
PARAM CHECK
YES
NO
TUNE
AU
START
LAST
RETURN
MANUAL
STOP
OMEGA ENGINEERING, INC.
STAMFORD, CONN.

SOAK AND RAMP

PRECISION
CONTROL
PLUS

- 9 Set Points
- 8 Ramp and Soak Intervals
- Thermocouple, RTD, Voltage, or Current Inputs
- Current, Voltage or Solid State Relay Outputs
- ON/OFF or PID Control

Description

The OMEGA CN-2010 Programmable Controllers utilize the latest microprocessor technology to improve reliability, accuracy and control. nputs can be either thermocouple or RTD temperature sensors, or voltage or current signals from virtually any process variable. The CN-2010 controllers feature Ramp and Soak functions (the capability to control the emperature and its rate of change over a predetermined time span). Up o eight Ramp and Soak intervals can be easily programmed into memory with the user friendly front keyboard. The versatility of this controller makes t ideal for both laboratory and industrial use. The precision, fine tuning controls allow easy adjustment for accurate process control, and the bright alphanumeric display provides process variable and set point information from on demand, plus continuous alarm, output and operating mode status.

Features

INPUTS

Thermocouple types J, K, T, E, R, S, B
3-wire 100 Ω Platinum RTD
($\alpha = 0.00385$)
0 to 5 V dc
4 to 20 mA dc current

CONTROL MODES

ON/OFF with Solid State Relay
P.I.D. with Solid State Relay, 4-20 mA or 0-5 V dc

ALARMS

Process or deviation SPDT relay, 1.0 amp @ 120/240 V ac

OUTPUTS

SSR: optically isolated, 50 mA @ 120/240 V ac
Current: 4-20 mA dc
Voltage: 0-5 V dc

MEMORY

Nonvolatile storage of input linearizations, control and alarm types and actions, and all routines and instructions for all display. Battery protected memory storage of set points, tuning parameters and measurement data.

Specifications

INPUTS

Line Voltage: 117 V ac
Sensor: Thermocouple: Types J, K, T, E, R, S, B
RTD, 3-wire, 100 Ω Platinum ($\alpha = 0.00385$)
Current: 4-20 mA
Voltage: 0-5 V dc
Power Consumption: 8 watts typical
Accuracy: ± 3°C
Repeatability: ± 0.5°F
Temperature Stability: 3 mV/°C
Operating Ambient: 5 to 55°C
Common Mode Noise Rejection: 140 dB
Sensor Break Protection: Upscale standard, alarms triggered
Display: 2 rows of 8 alphanumeric characters
Alarms 1 and 2: Independent, process or deviation, SPDT relay, 1.0 amp @ 120/240 V ac

ADJUSTMENTS

Cycle Time: Adjustable, from 1 to 60 seconds
Rate (Derivative): Adjustable, from 0.02 to 5 min. Independent primary and secondary rates
Reset (Integral): Adjustable, from 0.01 to 20 repeats per min. Independent for primary and secondary outputs
Proportional Band (Gain): Adjustable from 0 to 200% of span. Independent primary and secondary bands
Anti Reset Windup: (Standard) Inhibits reset when process variable is outside of the proportional band
ON/OFF Output Deadband: Selectable at 0.25, 0.50 or 1.00% of span
Auto/Manual: Bumpless transfer

OUTPUTS

Primary and Secondary: Independent
Current: 4 to 20 mA proportional, into 1 k Ω max load
Voltage: 0 to 5 V dc proportional, into min load at 1 k Ω
Solid State Relay: Optically isolated, SPST, normally open. 0.1 to 50 mA at 120/240 V ac
Alarms: 2 independent, process or deviation type, SPDT relay, normally open, rated 1 amp @ 120/240 V ac

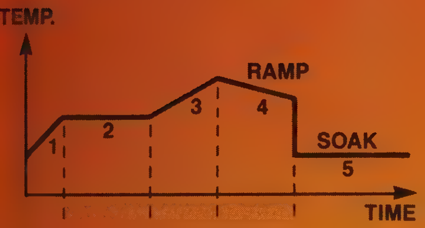
PROGRAMMED ADJUSTMENTS

Multisetpoint: Up to 9 independent set points may be stored
Ramp And Soak: Up to 8 RAMP (change in temperature over time) and SOAK (constant temperature over time) intervals with up to 254 repeat cycles
Times adjustable up to 100 hrs

Available Soon!

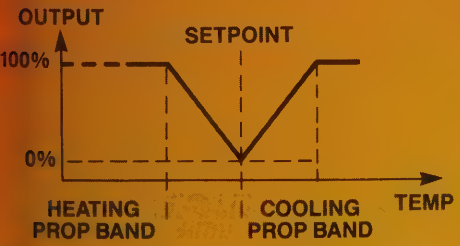
RTD input with 0.1° (F or C) Resolution! Consult Sales Department For Details.

Typical Control Profiles



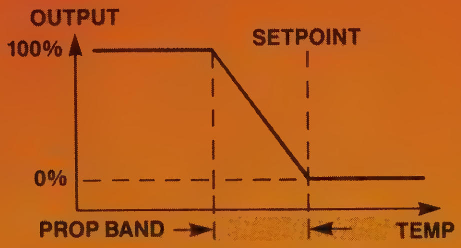
RAMP AND SOAK

Rate and time controls are provided for the process industries where more than one temperature is required to complete a process. The Ramp and Soak function is standard on all CN-2010 models, and can be used for heat treating, annealing, chemical baths or wherever rate control is needed.



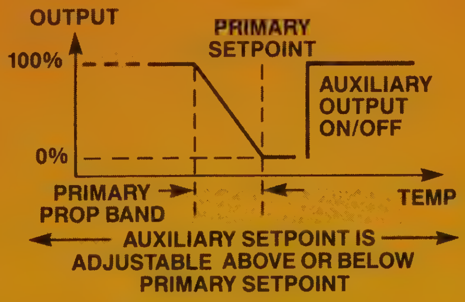
HEAT/COOL CONTROL

These controllers provide proportional control of both heaters and coolers for stable automatic control of processes, such as high efficiency water-cooled extruders. The CN-2010 will control the melt temperature precisely and with full user confidence.



SINGLE OUTPUT (Heat or Cool)

This type of controller is used with temperature baths, environmental chambers, ovens, furnaces, and other industrial or laboratory processes where only heating (or cooling) is required.



DUAL OUTPUT CONTROL For Separate Control Action

Dual output controllers are used in applications requiring two related control actions, such as cold start protection, quick start with auxiliary heaters, alarms, or wherever an auxiliary related control action is required. They can also be used for heat/cool applications where proportioning heating and on/off cooling is needed.

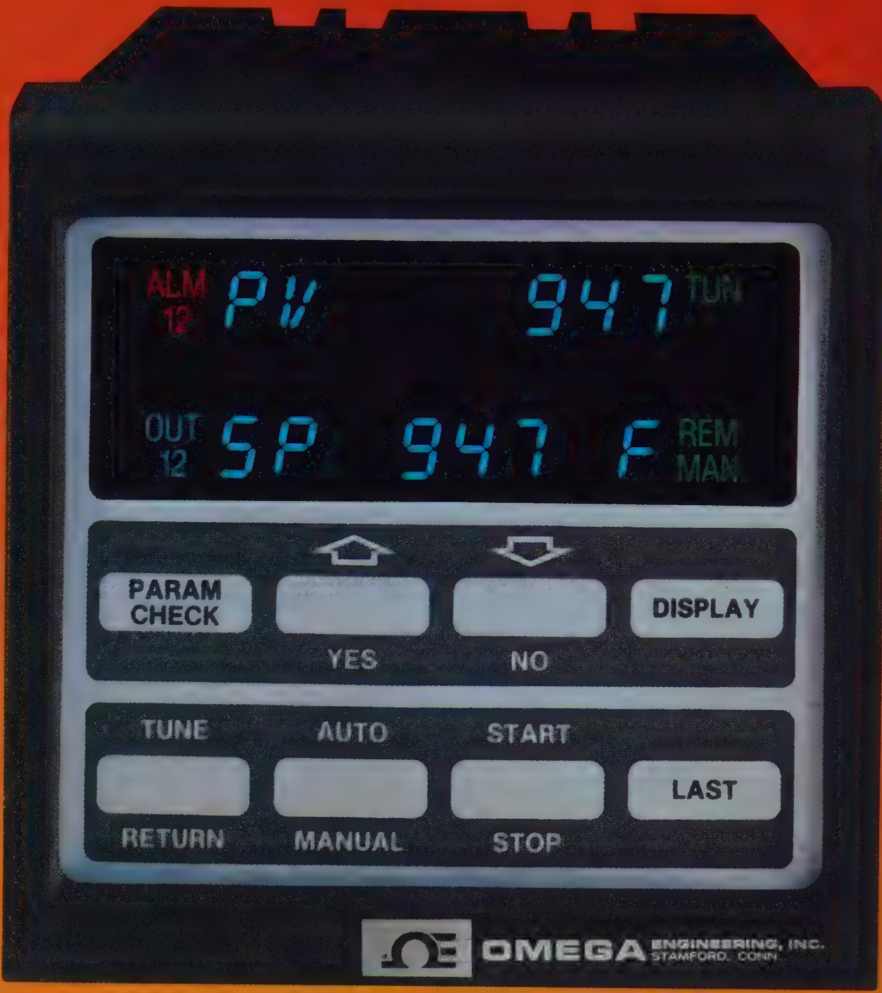
Programmable Temperature Controller Model CN-2010

PARAM CHECK
Advances all subroutines other than DISPLAY, one step at a time, in order to tune the controller, set ramp and soak intervals, or enter multi-setpoints.

DISPLAY
Advances the DISPLAY subroutine one step at a time, to show the present control parameters.

UP/YES
Increases displayed variable (i.e., set point) or is a positive response to displayed question.

DOWN/NO
Decreases displayed variable, or is a negative response to displayed question.



TUNE/RETURN
Calls up TUNE subroutine, or will return program to DISPLAY mode.

AUTO/MANUAL
Transfers control of outputs to and from automatic or manual control.

START/STOP
Turns the outputs on or off. Does not affect power to controller.

LAST
Allows user to back up within a subroutine to review or modify previously set variables.

VERSATILITY: ✓
The CN-2010 is available with a variety of input types including J, K, T, E, R, S, B thermocouple types, 3-wire RTD's, millivolt and current signals. Output types include Solid State Relay, Voltage or Current signals, with either ON/OFF or Proportioning Control modes.

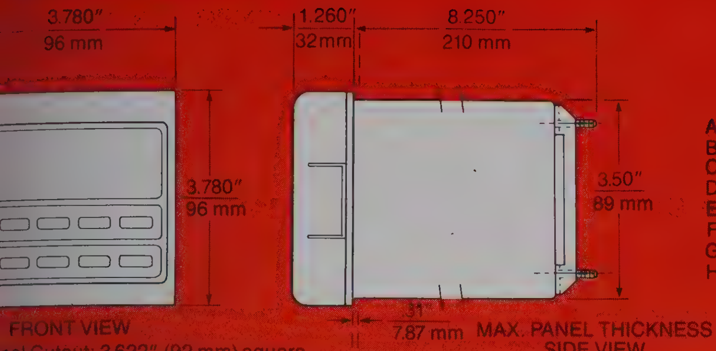
✓ **RAMP AND SOAK:**
Up to 8 intervals can be programmed into a CN-2010 to hold the temperature constant, or at a constant rate of change. Each interval can have a time duration of up to 100 hrs and up to 254 repeat cycles are possible.

✓ **MULTISETPOINT:**
The CN-2010 can store up to 9 different set points in its memory. A simple touch on the keypad can call up and activate any of the stored set points.

✓ **UNIQUE MULTICOLORED DISPLAY:**
Clear, easy to read alphanumeric display, with continuous indication of both output, alarm and operating statu

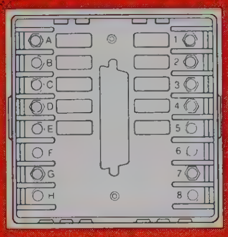
✓ **TOUCH PANEL KEYBOARD:**
Environmentally sealed touch panel is the operator interface to the CN-2010. All tuning instructions are entered here

Dimensions



FRONT VIEW
nel Cutout: 3.622" (92 mm) square

MAX. PANEL THICKNESS
SIDE VIEW



A — ALARM (2) NC
B — ALARM (2) C
C — ALARM (2) NO
D — OUT (2) HI
E — OUT (2) LO
F — − INPUT
G — + COLD JUNCTION
H — + INPUT

1 — ALARM (1) NC
2 — ALARM (1) C
3 — ALARM (1) NO
4 — OUT (1) HI
5 — OUT (1) LO
6 — AC SUPPLY
7 — AC SUPPLY
8 — GROUND

TERMINALS, REAR VIEW

Input Types

CODE	TYPE	RANGE	RESOLUTION	CODE	TYPE	RANGE	RESOLUTION
JF	J	−350/1390°F	1°F	JC	J	−210/760°C	1°C
KF	K	−400/2500°F	1°F	KC	K	−240/1370°C	1°C
TF	T	−450/750°F	1°F	TC	T	−270/400°C	1°C
EF	E	−400/1800°F	1°F	EC	E	−240/1000°C	1°C
RF	R	0/3200°F	1°F	RC	R	0/1760°C	1°C
SF	S	0/3200°F	1°F	SC	S	0/1760°C	1°C
BF	B	0/3200°F	1°F	BC	B	0/1760°C	1°C
P1	RTD	−300/1500°F	1°F	P2	RTD	−200/800°C	1°C
MA	Current	4 – 20 mA	1%	V5	Voltage	0 – 5 V dc	1%

*Note: Current and voltage input models display the input as a percentage of span (i.e., 0 at 0 V, 100 at 5 V). OMEGA can tailor each instrument to a custom range to match a transmitter or other transducer (i.e., 100 at 4 mA, 500 at 20 mA, to match a temperature transmitter with a range of 100-500°). Consult Sales Department for details. **Price: $30**

How To Order: SERIES CN-2010 SINGLE OUTPUT CONTROLLERS WITH TWO ALARMS

MODEL	CONTROL MODE	OUTPUT TYPE	PRICE
CN-2010-[*]	On/Off	50 mA SSR	$595
CN-2011-[*]	On/Off	1 A SSR	610
CN-2012-[*]	P.I.D	50 mA SSR	595
CN-2013-[*]	P.I.D	1 A SSR	610
CN-2014-[*]	P.I.D	4-20 mA	625
CN-2015-[*]	P.I.D	0-5 V dc	625

** Insert Input Code*

EXAMPLE:
Model No. CN-2013-KF-S6-A11-A24
Description—Model CN-2013 Controller, with 1 amp SSR w/PID output, and secondary output of 0-5 V dc, 1st alarm is high process, 2nd is low deviation type.
Price: $610 + 45 + 10 = $665

Note—If no alarms are specified, the standard alarm configurations of A11 and A22 are supplied at no extra cost.

Options

I	Output inversion for cooling applications	$10
C1 C2	Splash cover Tamper proof splash cover	25 25
SECONDARY OUTPUTS *Note—All secondary outputs are cooling only.*		
S1 S2 S3 S4 S5 S6	50 mA SSR, ON/OFF 1A SSR, ON/OFF 50 mA SSR w/PID 1A SSR w/PID 4-20 mA 0-5 V dc	15 30 15 30 45 45
ALARMS *Note—Standard configuration: Alarm 1: high process (Code A11); Alarm 2—low process (Code A22)*		
ALARM 1 A10 A11 A12 A13 A14	No alarm High process Low process High deviation Low deviation	10 std 10 10 10
ALARM 2 A20 A21 A22 A23 A24	No alarm High process Low process High deviation Low deviation	10 10 std 10 10

READ
475 °F
READ
1391 °F
OMEGA
READ
267 °C
OMEGA

Digital Controllers

$285 and up

Features:

- J or K Thermocouples
- Accuracy: ±0.5% Full Scale
- 1° Resolution
- Adjustable Proportional Band or On-Off
- Single and Dual Set Point Models
- Relay, Triac or 4-20 mA Output
- 1/4 DIN Metal Case
- Full Plug-In Construction

Sensor Type	Material Type	Range	Resolution	Number of Set Points	Model	Price
J	Iron/Constantan (Iron vs Copper-Nickel)	0 to 999° F 0 to 500° C	1°F 1°C	Single	4001JF 4001JC	**$285**
		0 to 999° F 0 to 500° C	1°F 1°C	Dual	4002JF 4002JC	**$320**
K	Chromel/Alumel (Nickel/Chromium vs Nickel/Aluminum)	0 to 1999° F 0 to 999° C	1°F 1°C	Single	4001KF 4001KC	**$285**
		0 to 1999° F 0 to 999° C	1°F 1°C	Dual	4002KF 4002KC	**$320**
RTD	Platinum RTD $\alpha = .00385$ ohms/ohm/°C	See pages P-10 and P-11.				

General:

The Omega 4000 series digital controller distinguishes itself by features, construction and operation one would expect to find only in controllers costing much, much more. Bright, easy to read, LED digits yield an unambiguous temperature indication which is not achievable with an analog controller. The standard unit includes adjustable proportional band, manual reset, plus a metal case with full plug-in construction allowing front removal of the entire control unit without disturbing the case and its rear wiring. Series 4000 Controllers are available in single and dual set point models with relay outputs as a standard. Triac or 4-20 mA optional outputs are offered on the first point at no additional cost. Models 4001 and 4002 lend themselves to a broad spectrum of control applications: single point control, dual set point control, and single point control with either high or low limit alarm. Truly a quality built controller at a remarkably low price.

Model 4001 Single Set Point Proportional and On-Off Controller $285

This versatile digital controller can be operated both as a proportional or on-off controller. Set the adjustable band width at up to 5% of full scale and it's a proportional controller. With the band width adjustment set fully counter clockwise, it's a "on-off" controller. The set point temperature is always available. Simply push the spring loaded set point switch to the right and the set point is digitally displayed. To change the set point, with the switch deflected to the right, adjust the knob to the right of the switch until you get the desired reading.

The standard Model 4001 has an internal SPDT relay (7 amp resistive at 120 VAC). This model is also available with optional Triac or 4-20 mA output in place of the relay. These options are covered in the Option and Specification sections.

Model 4002 Dual Set Point Controller $320

The first set point of the Model 4002 incorporates the same features as the Model 4001 and also can be ordered with the optional Triac or 4-20 mA output.

The second set point may be set at any value within the full span of the controller. It energizes the SPDT internal relay (3 amp resistive 120 VAC) which can be used as either an on-off control, a high limit alarm, or a low limit alarm. For an alarm with latching features an external latching relay and push button to reset are suggested.

The second set point is set and displayed using the same procedure as for the Model 4001 except the switch is deflected to the left and the left adjustment knob is used.

Option "T" Triac Output No Additional Charge.

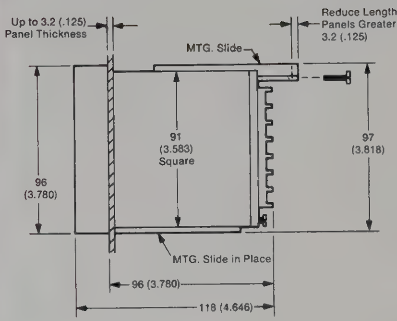
Option "T" replaces the relay output on the first set point with a solid state plug-in Triac which yields time proportional, or on-off switching. The Triac is rated at 2 amps continuous and 10 amps in rush for both 120/240 VAC service. For higher amperage loads the Triac may be used to drive higher rating solid state relays or mechanical contractors. Specify "Option T" after the model number when ordering. **No Charge**

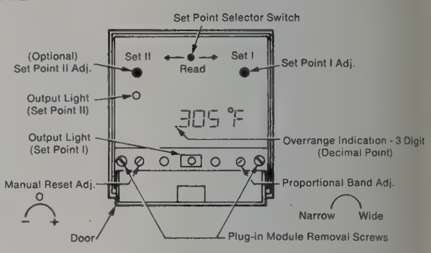
Option "F" (4-20 mA Output) No Additional Charge.

This option is applicable to the first set point only and is used to drive proportioning devices such as SCR power controller, motor positioners or electropneumatic actuators. The 4-20 mA DC output signal can be connected to a maximum of 1000 ohm resistance load. This signal is 20 mA at the low temperature end of the proportional band and is decreased linearly thru the band to 4 mA at the high temperature end. If the driven device is not isolated (ungrounded) an ungrounded thermocouple must be used with the Series 4000 which is designed for only one ground in the system. When ordering call out "Option MA" after the model number. **No Charge**

SET II
SET I
READ
267°C
OMEGA

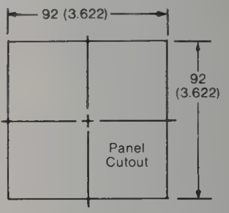
Specifications


Up to 3.2 (.125) Panel Thickness
Reduce Length for Panels Greater Than 3.2 (.125)
MTG. Slide
91 (3.583) Square
97 (3.818)
96 (3.780)
MTG. Slide in Place
96 (3.780)
118 (4.646)


Set Point Selector Switch
(Optional) Set Point II Adj.
Set II
Read
Set I
Set Point I Adj.
Output Light (Set Point II)
305 °F
Output Light (Set Point I)
Overrange Indication - 3 Digit (Decimal Point)
Manual Reset Adj.
Proportional Band Adj.
O
−
+
Narrow
Wide
Door
Plug-in Module Removal Screws

All dimensions in millimeters (inches)

Minimum center distance between units: 100 (3.937) vertical & horizontal


92 (3.622)
92 (3.622)
Panel Cutout

Thermocouple Input

Thermocouples	Type "J" & "K"
Max. T/C lead resistance	100 ohm for rated accuracy
Cold junction compensation	Automatic — electric
T/C Break protection	Built in, upscale on open sensor
Calibration Accuracy	Type J: ± 0.4% of span over 10 to 90% of range; Type K: ± 0.5% of span over 10 to 90% of range.
Common mode rejection	Max error +1°C with 240V, 60Hz applied as common mode signal between sensor input and chassis ground.
Series mode rejection	Max error ±1° with series mode signal of 100 MV PK-to-PK at 60 Hz

Control Output

1st. Set Point (Adjustable time proportional or on-off)	
Relay (Standard Model)	SPDT relay 7 amps resistive at 120 VAC 5 amps resistive at 240 VAC
Option "T" (Triac)	Solid state plug-in triac rated 2 amp holding and 10 amps in-rush
Option "F" (Current Proportional)	4-20 ma (DC) into 1000 ohm max
2nd. set point	
Relay (on-off only)	SPDT, rated 3 amps at 120 VAC

Adjustments

Proportional Band (gain)	0-5% of span
Manual Reset (off-set)	Adjustable
Cycle time	Automatically adjusts with band adjustment to give least wear with minimum ripple (10 sec. minimum total time).

Display and Indications

Temperature	Filtered LED, 3 or 3½ digits, 2 reading per second update. Readability is 1°F for 1°C.
Set Point	By spring loaded switch, 1st or 2nd set point is displayed in place of temperature. Set Point adjusted by 25 turn pot. .1°F or 1°C Setability
Outputs	LED indication for both 1st and 2nd set points. LED are "on" when output drive signal present. "On-off" indication on relay and triac model. Proportional intensity for option "F".
Temperature overrange	Red LED indication.

Set Point

Resolution	1°F or 1°C
Repeatability	±0.1% to ±0.2% of span
Adjustment	By 25 turn pot. See "Set Point" under "Display and Indication" section.
Power	120/240 VAC (+10%, −15%), 50/60 Hz. Power consumption less than 5 watts.

Environmental & Physical

Operating temperature	30-130°F
Weight	2 lb.
¼ DIN Case	Metal, full plug in, with screw terminal on rear. Adjustable brackets for panel mounting. Panel cut out is 3.622" vertical and horizontal dimensions.

RTD Digital Controllers

- High accuracy: to 0.1% of span
- Single and dual set points
- 1.0° and 0.1° models
- Adjustable proportion band or "on-off"
- Bright LED Display

®UL

SET II
READ
SET I
RTD
999 °F
OMEGA

Probe not included.
See Section E.

neral:

e OMEGA 4200 series is an ideal controller for RTD applications. is quality built linearized instrument is available in both 1.0° and 0.1° solution models. Higher accuracies, accuracies 5 to 10 times greater in the typical 1% meter indicating controller, are achieved through a que linearizing technique.

ght, easy to read, LED digits present an unambiguous temperature lication. Accuracy is enhanced through 3 wire lead compensation — a ture allowing the sensor to be up to 1000 ft. from the controller. The ndard unit includes adjustable proportional band, manual reset, s a metal 1/4 DIN case with full plug-in construction allowing nt removal of the control unit without disturbing the case d its rear wiring. The series 4200 controllers are ilable in single and dual setpoint models with ay output as a standard. Triac or 4-20 mA tional outputs are offered on the first t-point at no additional cost. ly a superior controller a remarkably v price.

Model 4201 Single Set-Point Proportional and On-Off Controller **$305**

is versatile digital controller can be operated both as roportional or on-off controller. Set the adjustable nd width at up to 3% of full span and it's a proportional ntroller. With the band width adjustment set fully unter clockwise, it's an "on-off" controller. The set-point nperature is always available. Simply push the spring ded set-point switch to the right and the set-point is itally displayed. To change the set point, with the switch flected to the right, adjust the knob to the right of the itch until you get the desired reading. The standard del 4201 has an internal SPDT relay (7 amp resistive at 0 VAC). This model is also available with optional Triac 4-20 mA output in place of the relay. These options are vered in the Option and Specification sections.

del 4202 Dual Set-Point Controller **$340**

e first set-point of the Model 4202 incorporates the me features as the Model 4201 and also can be dered with the optional Triac or 4-20 mA output.

The second set-point may be set at any value within the full span of the controller. It energizes a SPDT internal relay (3 amp resistive 120 VAC) which can be used as either an on-off control, a high limit alarm, or a low limit alarm. For an alarm with latching features an external latching relay and push button to reset are suggested.

The second set-point is set and displayed using the same procedure as for the Model 4201 except the switch is deflected to the left and the left adjustment knob is used.

Option "T" Triac Output No Additional Charge.

Option "T" replaces the relay output on the first set point with a solid state plug-in Triac which yields time proportional, or on-off switching. The Triac is rated at 2 amps continuous and 10 amps in rush for both 120/240 VAC service. For higher amperage loads the Triac may be used to drive higher rating solid state relays or mechanical contactors. Specify "Option T" after the model number when ordering.

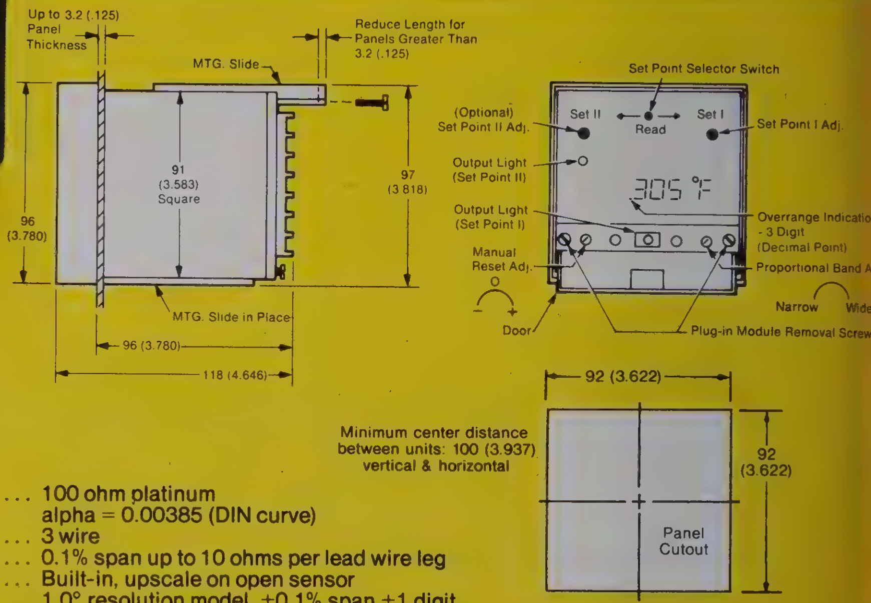
Option "F" (4-20 mA Output) No Additional Charge

This option is applicable to the first set point only and is used to drive proportioning devices such as SCR power controller, motor positioners or electropneumatic actuators. The 4-20 mA dc output signal can be connected to a maximum of 1000 ohm resistance load. This signal is 20 mA at the low temperature end of the proportional band and is decreased linearly thru the band to 4 mA at the high temperature end. If the driven device is not isolated (ungrounded) an ungrounded sensor must be used with the Series 4200 which is designed for only one ground in the system. When ordering call out "Option MA" after the model number.

Specifications

SET I
SET II
READ
-RTD
99.9
°F
OMEGA

Sensor Type	Range	Resolution	Accuracy ±1 digit	Number of Set Points	Model	P
100 ohm Platinum RTD α = .00385 ohm/ohms/°C	0 to 999°F 0 to 600°C	1°F 1°C	±0.1% of Span	Single	4201 PF1 4201 PC1	$3 $3
	0 to 999°F 0 to 600°C	1°F 1°C		Dual	4202 PF1 4202 PC1	$3 $3
	−199.9 to +199.9°F −199.9 to +199.9°C	0.1°F 0.1°C	±0.2% of Span	Single	4201 PF2 4201 PC2	$3 $3
	−199.9 to +199.9°F −199.9 to +199.9°C	0.1°F 0.1°C		Dual	4202 PF2 4202 PC2	$3 $3


Up to 3.2 (.125) Panel Thickness
Reduce Length for Panels Greater Than 3.2 (.125)
MTG. Slide
91 (3.583) Square
97 (3 818)
96 (3.780)
MTG. Slide in Place
96 (3.780)
118 (4.646)
Set Point Selector Switch
(Optional) Set Point II Adj.
Set II
Read
Set I
Set Point I Adj.
Output Light (Set Point II)
305 °F
Output Light (Set Point I)
Overrange Indicatio
- 3 Digit (Decimal Point)
Manual Reset Adj.
− +
Proportional Band A
Narrow
Wide
Door
Plug-in Module Removal Screw
92 (3.622)
Minimum center distance between units: 100 (3.937) vertical & horizontal
92 (3.622)
Panel Cutout

RTD Input

Type	100 ohm platinum alpha = 0.00385 (DIN curve)
Configuration	3 wire
External Lead Wire Resistance Effect	0.1% span up to 10 ohms per lead wire leg
Sensor Break Protection	Built-in, upscale on open sensor
Calibration Accuracy	1.0° resolution model, ±0.1% span ±1 digit 0.1° resolution model, ±0.2% span ±1 digit
Stability	0.1% for 30−130°F, 0.1% +10%−15% line voltage
Common mode rejection	Max error ±1°C with 240V, 60Hz applied as common mode signal between sensor input and chassis ground.
Series mode rejection	Max error ±1°C with series mode signal of 100 MV PK-to-PK at 60 Hz

Control Output

1st. Set-Point (Adjustable time proportional or on-off)

Relay (Standard Model)	SPDT relay 7 amps resistive at 120 VAC, 5 amps resistive at 240 VAC
Option "T" (Triac)	Solid state plug-in triac rated 2 amp holding and 10 amps in-rush
Option "F" (Current Proportional)	4-20 ma (DC) into 1000 ohm max

2nd. set point

Relay (on-off only)	SPDT, rated 3 amps at 120 VAC

Adjustments

Proportional Band (gain)	0-3% of span
Manual Reset (off-set)	Adjustable
Cycle time	Automatically adjusts with band adjustment to give least wear with minimum ripple (10 sec. minimum total time).

Display and Indications

Temperature	Filtered LED, 3 or 3½ digits, 2 reading per second update. Readability is 1.0° or 0.1° (°F or °C) depending on model
Set-Point	By spring loaded switch, 1st or 2nd set-point is displayed in place of temperature. Set-Point adjusted by 25 turn pot. 1.0° or 0.1° Setability.
Outputs	LED indication for both 1st and 2nd set-points. LED are "on" when output drive signal present. "On-off" indication on relay and triac model. Proportional intensity for option "F".
Temperature overrange	Red LED indication.

Setpoint

Resolution	1.0° or 0.1° (°F or °C) depending on model
Repeatability	±0.1% to ±0.2% of span
Adjustment	By 25 turn pot. See "Set Point" under "Display and Indication" section.
Power	120/240 VAC (+10%, −15%), 50/60 Hz. Power consumption less than 5 watts.

Environmental & Physical

Operating temperature	30-130°F
Weight	2 lb.
¼ DIN Case	Metal, full plug in, with screw terminal on rear. Adjustable brackets for panel mounting. Panel cut out is 3.622" vertical and horizontal dimensions.

Specifications and configurations are subject to change as advances in technology allow.

NEW! Microprocessor Based Temperature Controller

Model 6000

Lab Baths

Environmental Chambers

njection Molding

Blow Molding

Furnaces

Extruders

– PROCESS –
550
550
– SET POINT –
STATUS
HT
A1
CL
A2
SP
HG
A1
HC
A2
CG
RT
CC
INDEX
OMEGA ENGINEERING, INC
INDEX
ENTER

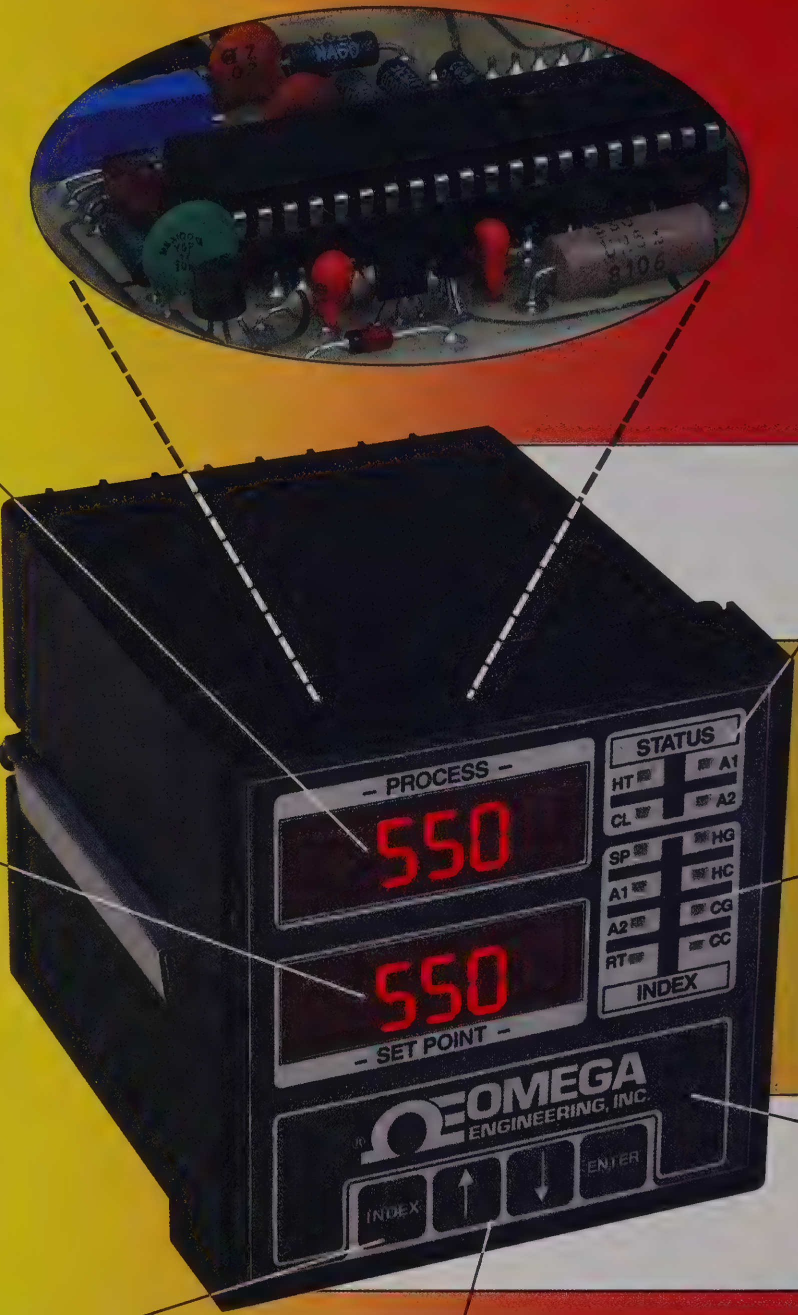
robe not included. See Sections
, B, D, and E for the complete
election of thermocouple and
TD probes.

Prices start at:

$395

One Controller For All Your Process Needs

Powerful Microprocessor provides extra features at low cost



Dual Digital LED Temperature Display

Both process temperature and set point can be observed simultaneously.

Process data is updated five times each second and digitally filtered to eliminate "noise" fluctuations.

Digital LED Function Display

All control parameters and alarm set points are displayed digitally for quick precise setting and repeatability.

°F/°C Switchable

Internal switch selects either °F or °C display eliminating need for conversion charts.

Separate "INDEX" & "ENTER" Touch Keys

Allows new control parameters or set points to be tried without loss of originally entered functions.

Internal Lockout Switch

Prevents accidental changes or tampering of control parameters, while still allowing set point changes.

Touch-Key Setup

Fingertip control. Switches provide tactile feedback and click when values are entered.

4 LED Status Indicators

Show output and alarm conditions.

Customer Selectable Process or Deviation Alarms

Internal switches allow alarms to be programme for either Process or Devi tion alarm and to energiz or de-energize on alarm.

8 LED Index Indicators

Shows the control function addressed.

Heat/Cool Outputs

Dual heat/cool proportio control with any combina tion of relay, 4-20 mA dc, Triac or 20 V dc Pulsed Output for S.S. Relays.

Sealed Front Panel

Durable one piece overla with molded-in red filter seals out dirt, dust and oil from display and switches.

Individual Adjustments

Separate heat gain, heat cycle time, cool gain, cool cycle time and single button auto rate/reset adjustments provide easy tuning.

Nonvolatile Memory

Retains process parameters when power is "o without battery back-up.

Microprocessor Based Temperature Controller

Model 6000

- Heating and Cooling Outputs
- Dual 4-Digit Display
- Dual Process or Deviation Alarms
- Easy Touch-key Setup
- Compact—¼ DIN Case
- Only 3-5/8″ Deep

– PROCESS –
550
550
– SET POINT –
STATUS
HT
A1
CL
A2
SP
HG
A1
HC
A2
CG
RT
CC
INDEX
OMEGA ENGINEERING, INC.
INDEX
ENTER

The Model 6000 Microprocessor-Based Controller provides the latest in heating and cooling control. A large dual 4-digit display shows process and set point temperatures at a glance. Three mode (proportional, integral and derivative) action eliminates offset as cooling and heating requirements change.

Touch-key setup eliminates all external knobs and protruding switches. Parameters are entered easily and can be locked in to prevent unauthorized tampering.

Heating and cooling outputs can be either relay, 4-20 mA, Triac or 20 V dc pulsed, in any combination.

Available with thermocouple types J, K or T, or RTD inputs, and ranges up to 2500°F (1370°C).

Single Set Point
Single Output
(Heat Only)

$395

Single Set Point
Dual Outputs
(Heat/Cool)

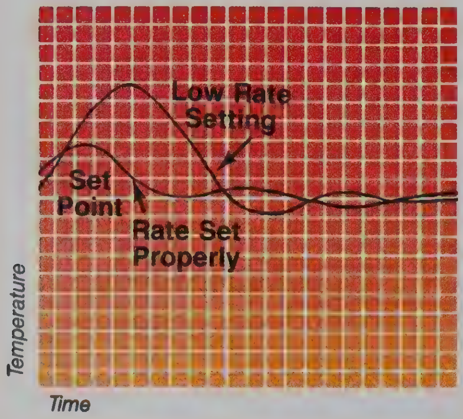
$430

See the complete OMEGA line of Temperature Probes to work with your controller in Sections A, D, and E.

Microprocessor Based Temperature Controller
Model 6000

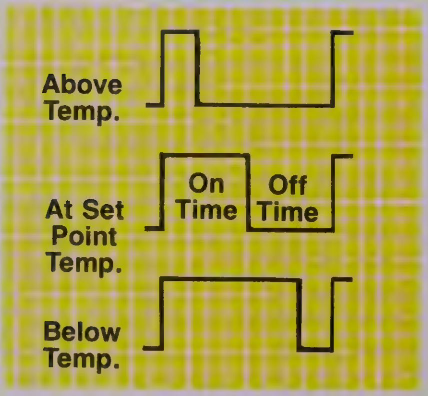
Rate with Automatic Reset

The rate function provides the controller with the ability to compensate for rapid changes in temperature. This function senses the rate of change, and applies immediate corrective action. Automatic reset, which tracks the rate, is used to eliminate offset (the difference between the set point and the stable process temperature). Using an integrator circuit, reset shifts the proportional band of the controller to correct for offset.



Heating and Cooling Cycle Times

Adjustment of the cycle times for both the heater and cooler are required to match the controller to the process. Cycle times should be set to the longest possible, depending on the process, for increased relay life.
For the heater, the amount of power applied is increased below set point, and decreased above set point.
For the cooler, the amount of power applied is decreased below set point, and increased above set point.



PID Control

OMEGA's unique Model 6000 microprocessor based controller was developed to satisfy the need of actual end users. Three mode (Proportional, Integral and Derivative) action eliminates offset (droop) as cooling and heating requirements change in the process and provides fast output response to rate of change and reduces temperature overshoot and undershoot.

The precision of the set point control is especially valuable because it produces more efficient operation, reduced reject rates and increased product quality.

Touch-Key Setup

All controls, parameters and function selections are entered at the touch of a key. All external knobs and switches have been eliminated. The completely digital controls can be indexed by touching one button, values can be adjusted at another touch and another touch enters the value. Once values are entered, they can be locked in with an internal switch to prevent unauthorized tampering.

Thermocouple Linearization

To assure accurate tracking between the display and the thermocouple, a precision program to linearize signal input from the thermocouple is programmed in the microprocessor. Linearization allows for more precise control and full use of the controllers range.

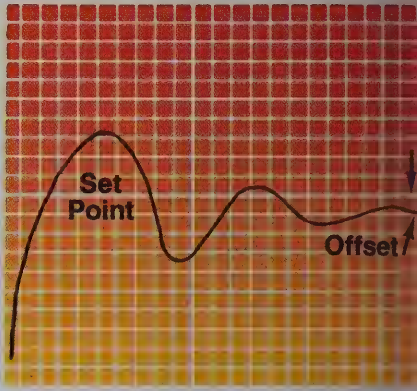
Dual Indication

Now you can compare process temperature and set point at a glance—hands free. The dual digital display concept has formerly only been available in high priced multifunction process controls.

Heat and Cool Gains

Gains set the controller for proportional control of the heating and cooling actions. Gain is the change control action required for a change the process temperature. It is usuall expressed in terms of the proportion bandwidth. Within the proportional band, the controller cycles on and o to control the process temperature. Below the band, heating action is at 100% (always on), and cooling actio at 0% (always off). Above the band, the heater is always off, and the cooler always on.

$$\text{Bandwidth (in degrees)} = \frac{\text{Full Scale Span (in degrees)}}{\text{Gain}}$$

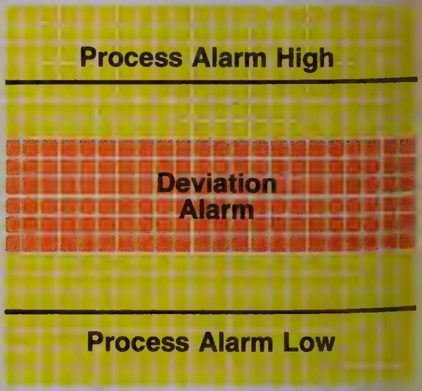


Process or Deviation Alarms

The process alarm will trip when the temperature is greater than the set point when configured as a high alarm.

It will trip when less than the setpoin when configured as a low alarm.

The deviation alarm will trip when th alarm setting is added (high) or subtracted (low) to the set point.



Microprocessor Based Temperature Controller

Model 6000

Microprocessors Reduce Size, Add Power

By using a powerful microprocessor and a highly sophisticated software package, more features have been included than have ever been available before in a controller this size. The OMEGA 6000 temperature controller incorporates two digital displays, touch-key operation, software linearized and stabilized thermocouple input with 3-mode PID heating and cooling control and dual alarms. It also includes a wide range of extra features that have been otherwise unobtainable like: °F to °C conversion; alarms that can be energized for temperature rise or fall and be selectable as process or deviation type; and a program restart circuit that eliminates program lock up due to transient voltage spikes or line voltage "brown out." Program automatically restarts within 20 milliseconds after condition passes.

low to Order:

Single Set Point
Single Output
Heat Only)

$395

(Insert Order Code)

IODEL 6000 - [ ] - [ ] - [ ]

Sensor Type and Range (Table 1)
Output (Table 2)
Alarms (Table 3)

Single Set Point
Dual Outputs
(Heat/Cool)

$430

(Insert Order Code)

IODEL 6000 - [ ] - [ ] - [ ] - [ ]

Sensor Type and Range (Table 1)
Output #1 (Heat) (Table 2)
Output #2 (Cool) (Table 2)
Alarms (Table 3)

TABLE 1

SENSOR TYPES AND RANGES

ORDER CODE	TYPE	RESOLUTION	RANGE
J	Iron/ Constantan	1°	0 to 1400°F (0 to 760°C)
K	Chromel/ Alumel	1°	0 to 2500°F (0 to 1370°C)
T	Copper/ Constantan	1°	−200 to 600°F (−129 to 316°C)
P1	100Ω RTD	1°	−328 to 1112°F (−200 to 600°C)
P2	100Ω RTD	0.1°	−99.9 to 199.9°F (−73.3 to 93.3°C)

Fahrenheit ranges switchable to Celsius

TABLE 2

OUTPUT TYPES FOR EITHER MODEL (Both Outputs)

Order Code	Description
R	7 A/5 A relay @ 120/240 V ac
MA	4-20 mA dc (proportional)
T	1 A Triac
DC	20 V dc pulsed voltage signal to drive Solid State Relay

NOTE: For dual output models, any combination of outputs is available.

TABLE 3

ALARMS (all models)

Order Code	Type	Add to list
A1	One auxiliary relay on-off (1° differential, customer selectable, process or deviation)	$30.00
A2	Two auxiliary relays on-off (1° differential, customer selectable, process or deviation)	$55.00

Microprocessor Based Temperature Controller Model 600

Specifications

Line voltage: 120/240 V ac ± 10-15%, 50-60 Hz

Sensor: J, K or T thermocouple, 100Ω Platinum RTD

Power consumption: Less than 6 VA (Instrument)

Ranges: J: 0 to 1400°F (0 to 760°C) K: 0 to 2500°F (0 to 1370°C) T: −200 to 600°F (−129 to 316°C) RTD1: −328 to 1112°F (−200 to 600°C) (1°) RTD2: −99.9 to 199.9°F (−73.3 to 93.3°C) (0.1°)

Accuracy: ±0.2% of full scale

Temperature stability: 5μV/°C Max 3μV/°C typ

Cold end tracking: 0.05°C/°C ambient

Operating ambient for rated accuracy: 0 to 55°C

Maximum thermocouple lead resistance for rated accuracy: 1000Ω

Series mode noise rejection: 80 dB

Common mode noise rejection: 120 dB

Sensor break protection: Upscale standard

Dual display: Process temperature displayed continuously; set point or other parameters updated on lower display.

Display update rate and filtering: Greater than 5 times per second. Analog and digital filtering techniques increase stability of process & display.

°F/°C: Internal switch selection—process, setpoint and alarms affected

Alarm 1 & 2: Adjustable over full range of control. LED displays alarm status. 3 amp relay at 120 V ac normally open contact. Reverse acting relay by switch selection for low alarms. Process/deviation mode selectable by internal switch.

Outputs:
(Single or Dual Output)

R-Relay (Time Proportional): SPST relay 7 amps resistive at 120 V ac, 5 amp resistive at 240 V ac, 50 VA inductive

MA-Current Proportional: 4-20 mAdc into 500 ohm max

DC-Pulsed Voltage: 0-20 V dc pulsed time proportioning signal for driving solid state relays with 500 ohms maximum input impedance.

T-Triac (Time Proportional): Solid state plug-in triac output. Rated 1 amp holding & 10 amp inrush

A1 & A2-Auxiliary Alarm Relays (On/Off): SPST relays, rated 3 amps at 120 V ac

Filtered LED Display: 4 digits for process, 4 digits for parameters

Linearization: Continuously calculated and updated using ROM based algorithm

Connections: Inputs and outputs via barrier strips with U.L. approve locking terminals

Dimensions: H: 3.78″ (96 mm) × W: 3.78″ (96 mm) × D: 4.65″ (118 r Depth behind panel: 3.78″ (96 mm)

Mounting: Channel slides and screws

Weight: 2 lbs. (.91 kg)

Front Panel Adjustments

Touch Key

INDEX Allows the following adjustments to be selected.

1) set point temperature	0 to s
2) alarm one temperature setting	0 to s
3) alarm two temperature setting	0 to s
4) rate with tracking reset (1:6 ratio)	**0 to 120
5) heat gain	†1 to
6) heat cycle time	*1 to 120
7) cool gain	†1 to
8) cool cycle time	*1 to 120

↑ ↓ up/down keys: increase/decrease values of above paramete

ENTER writes selected value to nonvolatile memory

NOTES: † setting to zero disables output

*setting to zero initiates 60 millisecond timebase for ultra fast cycling. Use with external solid state relays.

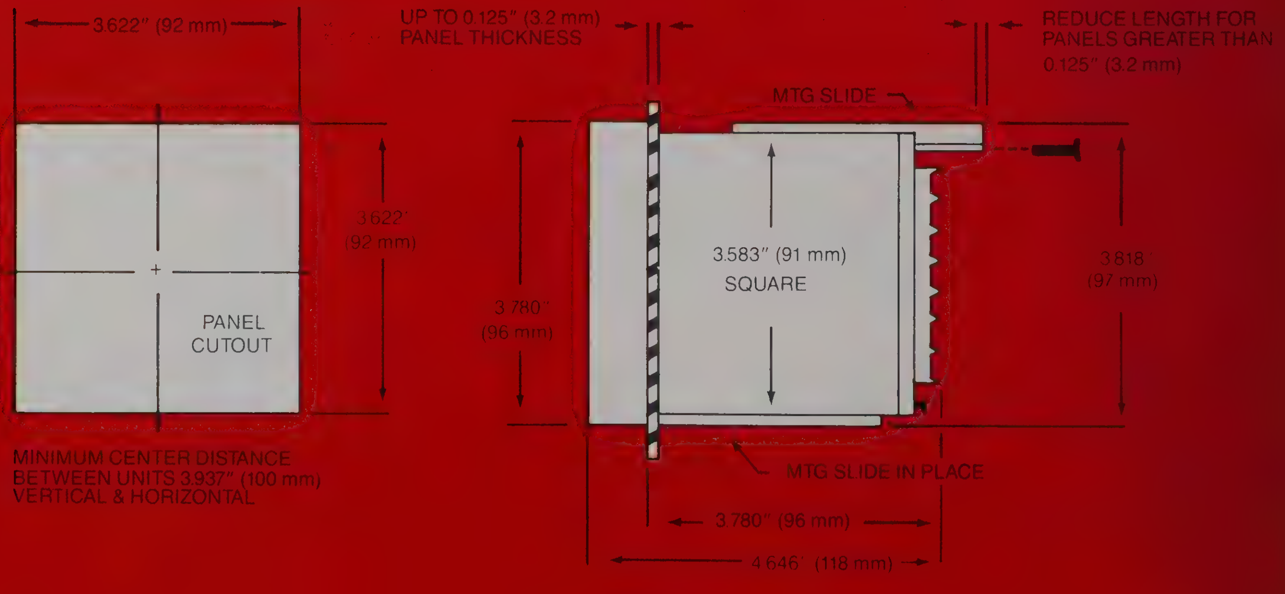
**Setting to *zero* disables reset and rate action for proportic only control.

Internal switch settings

A) 4 position DIP switch
  1) selects °F/°C display
  2) selects energized alarm two on hi/low (dev + /dev −) temperature
  3) selects energized alarm one on hi/low (dev + /dev −) temperature
  4) selects process or deviation alarm function

B) 2 position DIP switch
  1) selects reduced rate gain
  2) locks out front panel parameter entry except set point

CUT-OUT DIMENSIONS:


3.622″ (92 mm)
3.622″ (92 mm)
PANEL CUTOUT
MINIMUM CENTER DISTANCE BETWEEN UNITS 3.937″ (100 mm) VERTICAL & HORIZONTAL
UP TO 0.125″ (3.2 mm) PANEL THICKNESS
REDUCE LENGTH FOR PANELS GREATER THAN 0.125″ (3.2 mm)
MTG SLIDE
3.780″ (96 mm)
3.583″ (91 mm) SQUARE
3.818″ (97 mm)
MTG SLIDE IN PLACE
3.780″ (96 mm)
4.646″ (118 mm)

Digital and Analog Temperature Controllers

300
500
100
600
0
°F
TYPE J
BAND RES TIME
OMEGA ENGINEERING, INC.
1000
1500
500
2000
0
2500
°F
TYPE K
OMEGA ENGINEERING, INC.
150
250
50
300
0
°F
TYPE T
300
500
100
600
0
°F
TYPE J
RPM
RATE
VICTOREEN SLIM-MOX
180
TYPE J
OMEGA ENGINEERING, INC.
0/1000 °F

Prices start at

$140

- Modular plug-in circuitry
- Compact
- Wide selection of ranges
- Full 3-mode PID available
- Single or dual set points

OMEGA's Series 920 Solid State Controllers are the most versatile family of controllers on the market today. Available in J, K, T and E thermocouple calibrations, Series 920 instruments are available with a wide selection of output options and special features. Many of the options are also available as easy-to-install field kits.

+ 150
PUSH
SET
0/1000°F
TYPE J
OMEGA
ENGINEERING, INC.

Single and Dual Set Poir Digital Controllers

- Compact: Requires only 3⅞ inch panel depth
- Versatile: May be panel or surface mounted
- Push-to-engage set point
- Isolated wiring chamber
- Full 3-mode PID control available
- Front access to major adjustments
- High accuracy: ±0.5% of span

$280 **(D921)**

Model D921 and D922 Digital Controllers

The OMEGA D921 and D922 Digital Controllers are one of the most versatile controllers available today. Standard features include a plug-in 10 amp relay SPDT primary output, 10 amp relay SPST secondary output, full time proportioning control (adjustable to true on/off), easy to read LED display, push to engage set point knob and LED indication of relay status. They are available in a broad variety of ranges up to 1000°C/°F and J, K, E and T thermocouple calibrations.

The modular plug-in chassis allows a broad selection of optional outputs and control modes which are available as either factory installed options or easy to install field kits. These options include 1.5 and 15 amp solid state relays and a 4 to 20 mA proportional control output. The optional control modes include burst proportioning, isolated 4 to 20 mA signal and 3-mode proportional-integral-derivative (PID) control with either mechanical or solid state relays. The PID control is also available with the isolated 4 to 20 mA signal.

Ranges for Models D921, D922

Thermocouple Type	Code	Range
J	J31	0 to 650° C
	J36	0 to 1000° F
K	K35	0 to 1000° C
	K36	0 to 1000° F
E	E31	0 to 650° C
	E36	0 to 1000° F
T	T05	0 to 350° C
	T06	0 to 650° F
	T27	−85 to 350°C

For ordering information, see page P-22

Analog Temperature Controllers

vith Field Kits for Ranges and Options

- ligh accuracy: ±2% of span
- lepeatability: ±.1% of span
- Compact and versatile
- ull 3-mode PID option
- -5V dc Recorder Output

3-820
1000
1500
500
2000
0
TYPE K
2500
°F
OMEGA ENGINEERING, INC.

Analog Indicating Models I921 and I922

The **OMEGA I921 AND I922 Controllers** combine olid state accuracy with low cost. The I921 has a single et point and the I922 has two. They feature an easy-to-ead dial with a full 250° (angular) indicating meter and ime proportional control adjustable to true ON/OFF. Standard features on the I921 and I922 models include plug-in 10 amp relay, isolated wiring chamber, either 15 or 230V ac operation (field convertible) and push-o-engage set point. The I922 additionally features either tracking (standard) or non-tracking second set point. The I921 and I922 are available in J, K, E and T thermocouple calibrations, with a broad selection of ranges covering -350° to 2500°F. Both models have a red LED ndication of the (main) relay status. The I922 also has a green LED for status of the secondary relay.

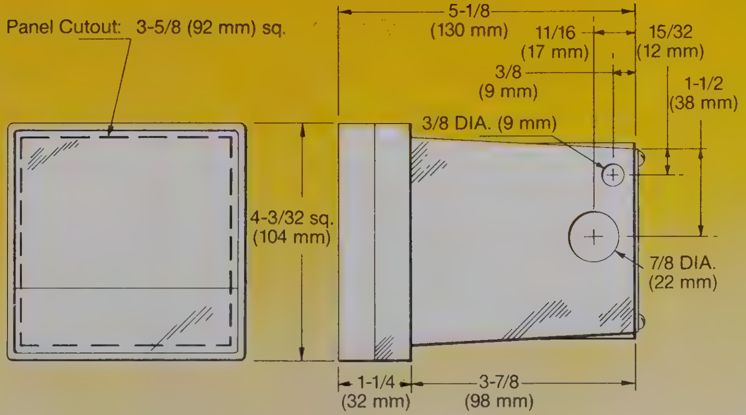
The versatile I921 and I922 models, as with all the Series 920 Controllers, are available with a wide variety of optional control modes and switching devices. These eatures are available as either factory-installed options or easy-to-install field kits. The optional switching devices include 1.5 or 15 amp solid state relays and a 4 to 0 mA proportional control output. Control modes available include burst proportioning, high or low limit vith reset switch, isolated 4 to 20 mA signal or full -mode proportional-integral-derivative (PID) control I921 only) with either mechanical or solid state relays.

Ranges:

The I921 and I922 Controllers are available in over 20 anges and 4 thermocouple types to satisfy all temperaure control applications. These units are field convertble to another range or thermocouple type with one of he easy-to-install range kits. These kits increase the versatility of the I921 and I922 by allowing the user to change the range or thermocouple calibration as his requirements change. The kits include a custom range chip and a self-adhesive dial. Only a screwdriver is required for the conversion. For a complete listing of all ranges and kits available for the I921 and I922 Controllers,See page P-21

For ordering information, see page P-22

$220 **(I921)**



3 834
300
500
100
600
0
°F
TYPE J
BAND RES TIME
OMEGA
ENGINEERING, INC.

Low Cost Non-Indicating Controllers

- Low cost, high quality
- Wide selection of ranges
- Setting accuracy: ±2% of range
- Single or dual set points
- Compact — only 3⅞ inch depth
- Modular solid state circuitry

$140 (E924)

Non-indicating Models E924 and E922

Introducing the PRICE LEADER in solid state controllers — the **Series 920 Non-indicating Models E924 and E922.** The E924 is a single set point model and the E922 has dual set points. These models combine both the low cost of non-indicating controllers and the high accuracy and dependability of solid state construction. Standard features on the E924 and E922 include a wide variety of ranges covering from −350 to 2500° F, a plug-in 10 amp relay, time proportioning output (adjustable to true on/off), J, K, E and T thermocouple calibrations and LED relay status indication. A broad variety of outputs and control modes are available. The optional outputs and control modes are available as either factory-installed options or as easy-to-install field kits. The list of options include 1.5 or 15 amp solid state relay outputs, burst proportioning and 4 to 20 mA proportional control output.

Ranges:

The E924 and E922 Controllers have a wide selection of standard ranges to choose from. In addition, all of the ranges are available as easy-to-install range kits. The conversion requires only a screwdriver. Remove the "old" range chip, plug in the new chip and place on a new self-adhesive dial. For a complete selection of the ranges available with the E924 and E922 (either as standard ranges or range kits) see table at right.

For ordering information, see Page P-22

Ranges for Models I921, I922, E924 and E922

Thermocouple Type	Range	A Code
J	0/250° F	J12
	0/400° F	J22
	0/300° C	J25
	0/600° F	J26
	0/425° C	J27
	0/800° F	J28
	0/1200° F	J30
	0/650° C	J31
K	0/400° C	K29
	0/1200° F	K30
	0/650° C	K31
	0/2000° F	K32
	0/1100° C	K33
	0/2500° F	K34
E	0/250° F	E12
	0/600° F	E26
	0/1200° F	E30
	0/650° C	E31
T	−350/100° F	T08
	0/300° F	T20
	−85/230° C	T23
	−125/450° F	T24

1. When ordering a Series 920 unit (other than Model D921), specify the range in column A above. **For D921 ranges, see Page P-19.**
2. To order an optional range kit, specify the model number and range code, i.e., E924-T08 is a −350 to 100°F range for a Type T thermocouple, Model E924. Kits come with range "chip" and self-adhesive dial. List price **$10.**

Color bands indicate our most popular ranges. These are normally available for the fastest delivery.

Note: Specify 115 V or 230 V when ordering Models E922 and E924

How to Order:

To order a new OMEGA Series 920 Controller, follow the guide below. Please specify model type (1), thermocouple calibration (2), range (3), output (4) and control mode (5); with dual output models also specify the secondary output and control mode (6). Then, add any required options (7).

Catalog No.:

1	2	3	4	5	6	7
☐☐☐☐	☐	☐☐	☐	☐☐	☐☐☐	☐☐☐☐

1. Model Type	Price
E924* *	$140
E922* *	190
I921	220
I922	260
D921	280
D922	335

2. Thermocouple Calibrations

(Included in Range Code)
J: Iron/Constantan
K: Chromel/Alumel
E: Chromel/Constantan
T: Copper/Constantan

3. Standard Ranges

See page P-21 for Analog and Non-indicating models and page P-19 for Digital models.

4. Primary Switching Device	Code	Price
10 amp Mechanical Relay	A	—STD—
1.5 amp Solid State Relay	D	$ 34
4-20 mA proportional output (mode 40 or 50 only)	G	—See 5—
15 amp Solid State Relay	F	$ 75
0-24 V dc switched output	B	5

5. Primary Control Mode	Code	Price
Time prop. convertible to on/off	20	—STD—
Isolated 4-20 mA prop. control mode	40	$ 65
PID with time prop. (D921 and I921 only)	30	46
PID with isolated 4-20 mA signal (D921 and I921 only)	50	110
*FM approved high limit with reset switch (E924, I921 10 amp relay only)	65	30
Burst proportioning	—See 7C—	

6. Secondary Output & Mode	Code	Price
Note: Models E922 and I922 ONLY		
On/Off 10 amp relay	L12	—STD—
On/Off 10 amp relay (D922)	L13	—STD—
On/Off 1.5 amp SSR	M12	$34
High limit w/reset switch	L62	21
Time prop.	L22	16
Time prop. w/1.5 amp SSR	M22	50

7A. Miscellaneous Options	Code	Price
NOTE: All options below require a longer delivery time.		
Downscale T/C break protection	E552	$ 5
Surface mount bracket (N/A output F)	E601	10
Splash cover	Specify	17.50
Auxiliary 0-5V dc Recorder signal (D921, E922 only)	E502	15

7B. Options-Switching Devices	Code	Price
*Output inversion — primary (N/A E924)	E150	$10
*Output inversion — secondary (I922, E922 only)	E250	10
*Nontracking second output (I922, E922 only)	E210	12

Instruments are available with additional LED's for indication of the power supply and the relay (for cooling applications). Consult Sales Department for details.

7C. Options-Signal Forms	Code	Price
*Low limit w/reset primary mode (E924, I921 only, mode A20 req'd.)	E161	$25
*Low limit w/reset 2nd mode (E922, I922 only, mode L12 req'd.)	E261	25
*Adjustable on/off differential (mode 20 req'd.)	E100	10
*Burst proportioning (mode 20 or 30 req'd.)	E102	10

***See Page P-23 for specifications**

Ordering Example: E922-J27-F-20-M12-E210

This is an E922 dual set point non-indicating controller with a 0-425°C range with a Type J (Iron-Constantan) thermocouple. It has the 15 amp solid state piggyback relay with time proportioning for the primary set point and an on/off 1.5 amp SSR control for the second set point. Option E210 is the nontracking (independent) second set point.

The cost of this unit is: $190 (for the E922) + $75 (for the 15 amp solid state piggy back relay) + $34 (for the on/off 1.5 amp SSR) + $12 (for the nontracking second set point), for a total cost of $311.

*** * Specify 115 V or 230 V when ordering Models E922 and E924**

780
PUSH
TYPE J
0/1000 °F
OMEGA ENGINEERING, INC.
1000
1500
2000
500
2500
0
°F
TYPE K
OMEGA ENGINEERING, INC.
300
100
500
0
600
TYPE J
°F
BAND RES TIME
OMEGA ENGINEERING, INC.

Specifications

Panel Cutout: 3⅝″ (92 mm) sq. per DIN-43700

INPUTS

Thermocouples: Types J, K, T and E; cold junction compensation.

- Standard upscale break protection, field convertible to downscale.
- Lead Resistance: 1° F shift per 100 ohms.
- Interchangeability: range chips permit interchange of any standard analog thermocouple range.

MODES/SIGNAL FORMS

Time Proportioning to On/Off:

- Cycle time: adjustable approximately 2-36 sec.
- Bandwidth: adjustable 0-10% of span, with set point in the center.
- Manual Reset: adjustable ±12% of span
- Field convertible to on-off mode with differential approximately .25% of span, symmetrical around set point.

Burst Proportioning:

- Same as time proportioning except cycle time adjustable approximately 0.2 to 3.6 sec. (Not for use with 10 amp relay.)

PID:

- Proportional-Integral-Derivative (3 modes).
- Internal jumpers allow selection of integral between 0 and .4 repeats per minute and derivative between 0 and 3 cycles per second.

4-20 mA (Isolated):

- 20 mA at lower end of proportional bandwidth, approximately 12 mA at set point, 4 mA at upper end of bandwidth. Bandwidth adjustable 0 to 6% of range span with set point in the center. Isolated optically and by transformer.

SWITCHING DEVICES

10 amp Mechanical Relay:

- Plug-in for easy replacement.
- Rated 10 amp @ 115 V ac resistive, 5 amp at 240V ac resistive. SPDT.

1.5 amp Solid State Relay (SPST):

- Rated 1.5 amps @ 130° F ambient temperature, resistive or inductive, 24 to 230V ac.
- Surge current 30 amps for one cycle. Typical off-state leakage current 6 mA, @ 230V ac.
- Zero crossing, optically isolated.

15 amp Solid State Relay (SPST):

- Rated 15 amps @ 130° F ambient temperature, resistive or inductive, 24 to 230V ac.
- Surge current 200 amps for one cycle. Typical off-state leakage current 6 mA, @ 230V ac.
- Zero crossing, optically isolated.
- Plugs into controller back and increases depth 1⅞″.

High or Low Limit Modes with Reset Switch
(10 amp mechanical relay required.)

- Available with primary or secondary outputs.
- Lock out on rising (falling) temperature.
- Manual reset switch.

Output Inversion

- For cooling applications.
- Available with solid state or mechanical relay.
- Failsafe control during power failure.

Nontracking Second Output

- Independent of primary set point.
- Adjustable over 100% of span.

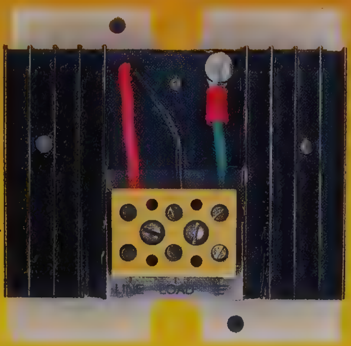
Adjustable On/Off Differential

- Adjustable from .13% to 3.5% of span, symmetrical around set point.
- Available only on primary set point.

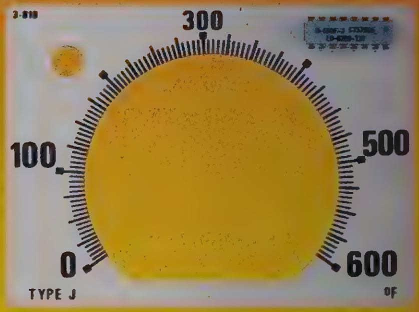
Plug-in Field Kits

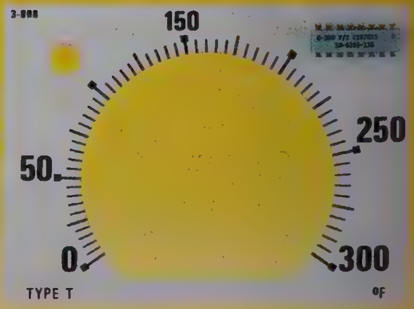
	List Price
KIT #62150-1 Mounting bracket	**$8.75**
KIT #62150-2 4-20 mA isolated (Model I921)	**$70**
KIT #62150-4 1.5 amp solid state relay, 24-230 V ac, zero crossing	**$40**
KIT #62150-5 15 amp solid state relay for plug-in to back of enclosure	**$80**
KIT #62150-6 Burst proportioning .2 to 3.6 sec. cycle time	**$ 6**
KIT #62150-7 Automatic Reset/Integral and Derivative (PID)	**$46**
Replacement Part 62138-61 Standard 10 amp electro-mech-relay	**$10**
KIT #62150-8 0-24 V dc switched output	**$12**
KIT #62150-167 4-20 mA, isolated (Model D921)	**$70**

15A SSR

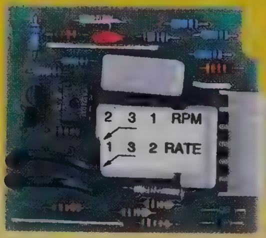


Range Kits





PID Control



1.5A SSR

62138-72
1.5AMP SSR

Process Controllers

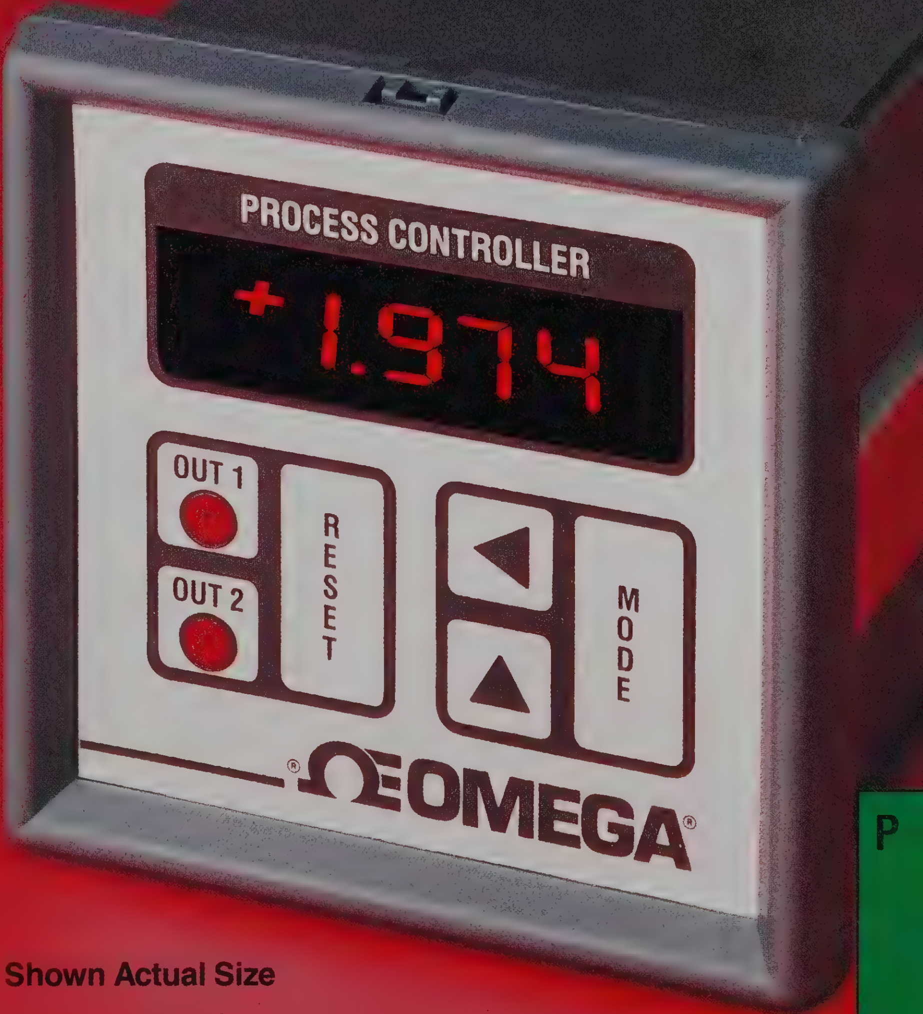
Series CN-25

NEW!

The CN-25 Series of process controllers is a family of low cost digital controllers for a variety of control applications. A CN-25 can accept input from virtually any sensor, transducer or transmitter, and provide accurate and reliable control. The CN-25 controllers can be used to control temperature, pressure, rates, flows, volume and power levels and other process variables. CN-25 controllers are available with ON/OFF or PID control, with either mechanical relay, Triac or 4 to 20 mA output. CN-25 controllers are also available with a BCD digital or RS-232C loop output. ON/OFF models have dual set points with either single or dual outputs, and PID models are single set point, single output controllers, and are available with either alarm or second output.

Measure and Control

- ✓ Temperature
- ✓ Pressure
- ✓ Current
- ✓ Voltage
- ✓ Flow/Rate
- ✓ Strain Gage
- ✓ True RMS



Shown Actual Size

Prices start at
$253

Series CN-25

Temperature

The CN-25 Temperature Controllers are designed for use with either J, K, T, E, R, S, B, and N thermocouples, and are available with ranges covering −245 to 1999°F or −150 to 1750°C. The CN-25B accepts 3 or 4 wire Platinum RTD's (100Ω, α = 0.00385). These two models can be used in virtually any temperature control application. The CN-25A is available with either °C or °F readout; the CN-25B is user selectable for temperature units.

- 8 Thermocouple Types
- 3 or 4 Wire RTD's
- ON/OFF or PID
- Relay, Triac, 4-20 mA
- ±2.5°F Accuracy

See pages M-7 and M-8 for specifications of thermocouple and RTD input models. See page P-27 for general specifications.

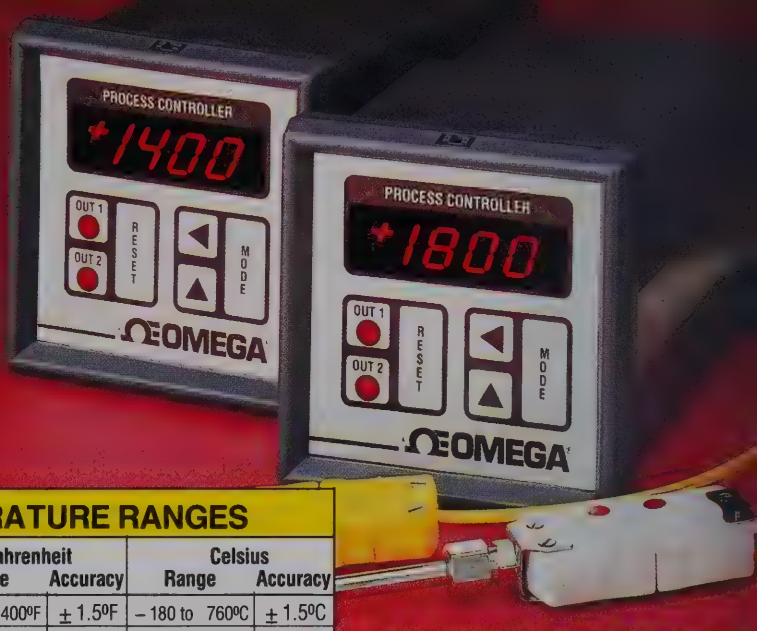
RTD

CN-25B-P1

$393

CN-25B-P2

$424


PROCESS CONTROLLER
1400
OUT 1
OUT 2
RESET
MODE
OMEGA
PROCESS CONTROLLER
1800
OUT 1
OUT 2
RESET
MODE
OMEGA

TEMPERATURE RANGES

Sensor Code	Res.	Fahrenheit Range	Fahrenheit Accuracy	Celsius Range	Celsius Accuracy
J	1°	−170 to 1400°F	±1.5°F	−180 to 760°C	±1.5°C
K	1°	−50 to 1999°F	±2.5°F	−50 to 1250°C	±2.1°C
T	1°	−245 to 750°F	±2.5°F	−150 to 400°C	±1.5°C
E	1°	−75 to 1440°F	±2.5°F	−95 to 840°C	±2.1°C
R	1°	+200 to 1999°F	±2.5°F	300 to 1750°C	±2.5°C
S	1°	100 to 1999°F	±2.5°F	335 to 1750°C	±2.3°C
B	1°			745 to 1820°C	±1.9°C
N	1°			−15 to 1300°C	±2.1°C
P1	1°	−328 to 1472°F	±(0.05% rdg + 1.5 digits)	−200 to 800°C	±(0.05% rdg + 1.5 digits)
P2	0.1°	−199.9 to 199.9	±(0.05% rdg + 1.5 digits)	−160 to 199.9°C	±(0.05% rdg + 1.5 digits)

THERMOCOUPLE

CN-25A-[↑]-[↑]

Sensor code

F/C

$406

High Performance, Low Cost

Voltage/Current

- dc Voltage- CN-25F
- Average Responding ac-V/A CN-25G
- True RMS ac-V/A CN-25H
- Input Signals up to 2A ac, 200 V dc, 500 V ac, 200 mA dc

See pages M-12, M-13 and M-14 for specifications of voltage or current input models. General specifications on page P-27

PROCESS CONTROLLER
100.0
OUT 1
OUT 2
RESET
MODE
OMEGA
PROCESS CONTROLLER
1.974
OUT 1
OUT 2
RESET
MODE
OMEGA
PROCESS CONTROLLER
199.8
OUT 1
OUT 2
RESET
MODE
OMEGA

True RMS

CN-25H

$425

dc VOLTAGE

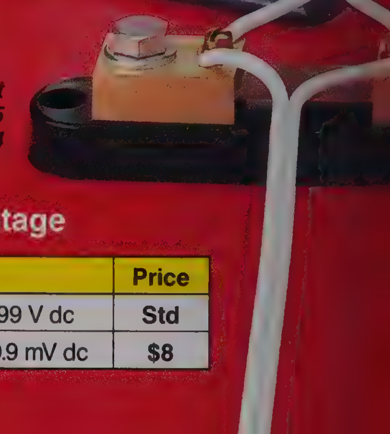
CN-25F

$253

ac LINE

CN-25G

$351



50 Amp Shunt Model 880-A5 See page C-14

INPUT RANGES

CN-25G-[ ] AC Line

Code	Range
A1	0 to 199.9 V ac
A2	0 to 300 V ac
A3	0 to 199.9 mA ac

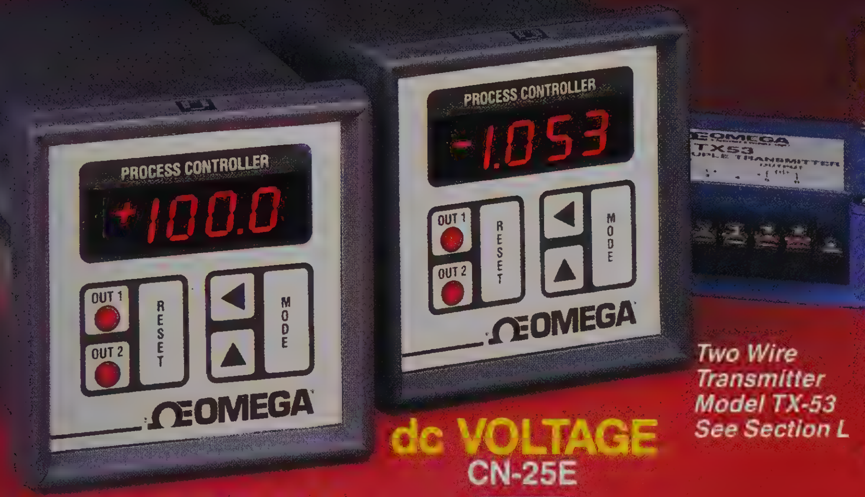
CN-25H-[ ] TRMS

Code	Range
R1	0 to 1.999 V ac
R2	0 to 19.99 V ac
R3	0 to 199.9 V ac
R4	0 to 500 V ac
R5	0 to 199.9 mA ac

CN-25F-[ ] dc Voltage

Code	Range	Price
V1	−1.999 to +1.999 V dc	Std
V2	−199.9 to +199.9 mV dc	$8

Series CN-25


PROCESS CONTROLLER
+100.0
OUT 1
OUT 2
RESET
MODE
OMEGA
PROCESS CONTROLLER
-1.053
OUT 1
OUT 2
RESET
MODE
OMEGA
OMEGA
TX53

Two Wire Transmitter Model TX-53 See Section L

CURRENT LOOP
CN-25D
$381

dc VOLTAGE
CN-25E
$381

Voltage/Current

The current loop and dc Voltage models of the CN-25 Series are easy to use, versatile controllers, able to accept inputs from a variety of voltage or current transmitters, and can be used to control temperature, pressure, flow, or displacement, with a display of output data in user desired units.

- Designed to IEC-348-Class II
- Floating Input to Eliminate Ground Loops
- Wide Selection of Span, Offset and Slope
- Overrange Indication and Protection
- Easy to Change Input Ranges

INPUT RANGES

CN-25D-[ ]

Code	Range
I1	0 to 20 mA
I2	4 to 20 mA
I3	0 to 50 mA
I4	10 to 50 mA

CN-25E-[ ]

Code	Range
E1	0 to 5 V dc
E2	1 to 5 V dc
E3	0 to 10 V dc
E4	– 10 to 10 V dc

See pages M-10 and M-11 for specifications of current loop and dc voltage input models. General specifications on page P-27.

Single Loop Digital Controllers

PRESSURE/ STRAIN GAGE
CN-25J
Consult Sales for prices

PROCESS CONTROLLER
1.511
OUT 1
OUT 2
RESET
MODE
OMEGA
PROCESS CONTROLLER
25.0
OUT 1
OUT 2
RESET
MODE
OMEGA

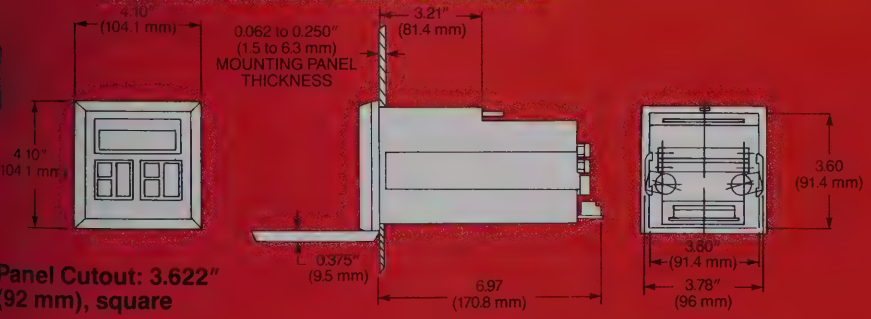
RATE/FLOW
CN-25C
$415

The CN-25 controllers for rate and pressure control accept input from a variety of transducers, including magnetic pickups, ac tachometers, photocells, and pressure and strain gage transducers. Available with either ON/OFF or PID control modes, and relay, triac or 4-20 mA output, the CN-25C and CN-25J are ideal in rate or pressure control applications.

- Rate/Flow and Pressure/Strain Gage
- 5 to 30 mV Input from Pressure Transducer
- Pulse or Sine Input Over Wide Range of Amplitudes and Frequencies
- Isolated Input (to analog ground) to Ensure Reliable Data in Extreme Conditions
- Automatic Threshold and Hysteresis Adjustment

See page M-9 for specifications of rate controllers. Consult Sales Department of specifications of pressure controllers. General specifications on page P-27

Series CN-25 DIMENSIONS


4.10"
(104.1 mm)
4.10"
(104.1 mm)
0.062 to 0.250"
(1.5 to 6.3 mm)
MOUNTING PANEL
THICKNESS
3.21"
(81.4 mm)
0.375"
(9.5 mm)
6.97
(170.8 mm)
3.60
(91.4 mm)
3.60"
(91.4 mm)
3.78"
(96 mm)

Panel Cutout: 3.622" (92 mm), square

PROCESS CONTROLLER
1400
OUT 1
OUT 2
RESET
MODE
ΩEOMEGA

Process Controllers

Series CN-25

How to Order

1. Specify Model CN-25 controller, with desired input type (letter code—A, B, C, D, E, F, G, H, or J).
2. Specify desired input range (all except C and J).
3. Specify desired control mode and output type (Table 1).
4. Specify any desired options (Table 2).

CN-25-[1]-[2]-[3]-[4]

Letter Code
Range
Control Mode and Output
Options

Pricing:
Prices shown on pages P-25 and P-26 are for single output, ON/OFF controllers with relay output.
To order another control mode, output type and/or options, add the price listed to the total cost.

Examples:
CN-25A-JF-M4-AL-RS: CN-25 temperature controller, type J thermocouple input, °F display, PID control with Triac, alarm and RS-232C loop. Cost: **$553**

CN-25F-V2-M1-S1-A-220V: CN-25 dc Voltage controller, −200 to +200 mV input range, ON/OFF control with relay, ON/OFF with relay second output, analog output, 220 V ac line voltage. Cost: **$317**

TABLE 1—Control Mode and Output Type

Order Code	Control Mode	Output Type	Description	Price
M1	ON/OFF	RELAY	dual setpoint, single output, user selectable, heat/cool	Std
M2	ON/OFF	TRIAC		$12
M3	PID	RELAY	single setpoint, single output, user selectable, heat/cool	26
M4	PID	TRIAC		38
M5	PID	4-20 mA		44

TABLE 2—Options

Order Code	Description	Price
AL	Alarm (PID models only)—not available with second output. User selectable process/deviation, high low.	$26
S1*	Second output—relay	26
S2*	Second output—Triac	38
S3*	Second output—4 to 20 mA (not available with ON/OFF controllers)	44
A	Analog output	30
D	BCD digital output (not available with RS-232C loop)	67
RS	RS-232C current loop (not available with BCD output)	83
220V	220 V ac line voltage	N/C

* Second output not available with alarm (PID models). Second output has same control mode as first output. User selectable heat/cool (all models) or process/deviation, high/low alarm (on/off models only).

Specifications

For specifications on input, performance, and analog output, see pages M-7 through M-14 for the "199 Letter Series" of process monitors.

GENERAL:

Display: 0.56″ (14.2 mm) LED, 3½ digits, polarity, overrange indication
Analog to Digital Conversion: Dual slope, 3 phase conversion with automatic zero correction; complete conversion each cycle; 2.5 conversion/sec.
Line Voltage: 110 or 220 V ac
Consumption: less than 4 watts typical
Operating Ambient: 14 to 122°F (−10 to 50°C)
Storage Ambient: −40 to 185°F (−40 to 85°C)
Relative Humidity: 0 to 90%, noncondensing
Common Mode Voltage: ±1400 V dc or ac peak
Rejection Ratio: 160 db typ.
BCD Output: 3½ decimal digits, 17 bits for data, polarity, overrange, outputs 1 and 2; selectable logic; parallel 3-state outputs enable in groups of 4 bits; 6 LSTTL loads each; TTL/CMOS compatible
RS-232C/20 mA Loop: 300 or 1200 baud, selectable at connector. 10 bit word length. Half duplex protocol. Simple command/reply format. 25 pin D connector.

OUTPUTS:

Mechanical Relay: SPDT, rated 5/2.5 A @ 110/220 V ac.
Triac: 2 A @ 110/220 V ac. (25°C).
Current Loop: 4 to 20 mA, isolated to 500 V.
Alarms: SPDT, rated 5/2.5A @ 110/220 V ac.

LOW COST DIGITAL CONTROLLER

Solid State Temperature Controllers Series 300

The Series 300 Digital Temperature Controllers are versatile, high performance, precision controllers for type J r K thermocouples. Cold junction compensation and upscale thermocouple break protection are standard eatures. The units have high operating accuracy of ±0.5% of span and useradjustable reset to compensate for extremely large or small processes.

The time proportional circuit is factory set to 3.5% of span, and cycle time is set at 20 seconds nominal. The output elay contacts are rated at 8 amps at 20 V ac and 4 amps at 240 V ac. A ⅛ DIN case with mounting panel cut out dimensions of 3.622″ (92mm) × 1.772″ 45 mm), make it the most space savng precision controller available.

- **J or K Thermocouple**
- **Accuracy: ±0.5% of Range**
- **1° Resolution**
- **Bright, Efficient LED Display**
- **Proportional Control**
- **Recorder Output**

⅛ DIN Package

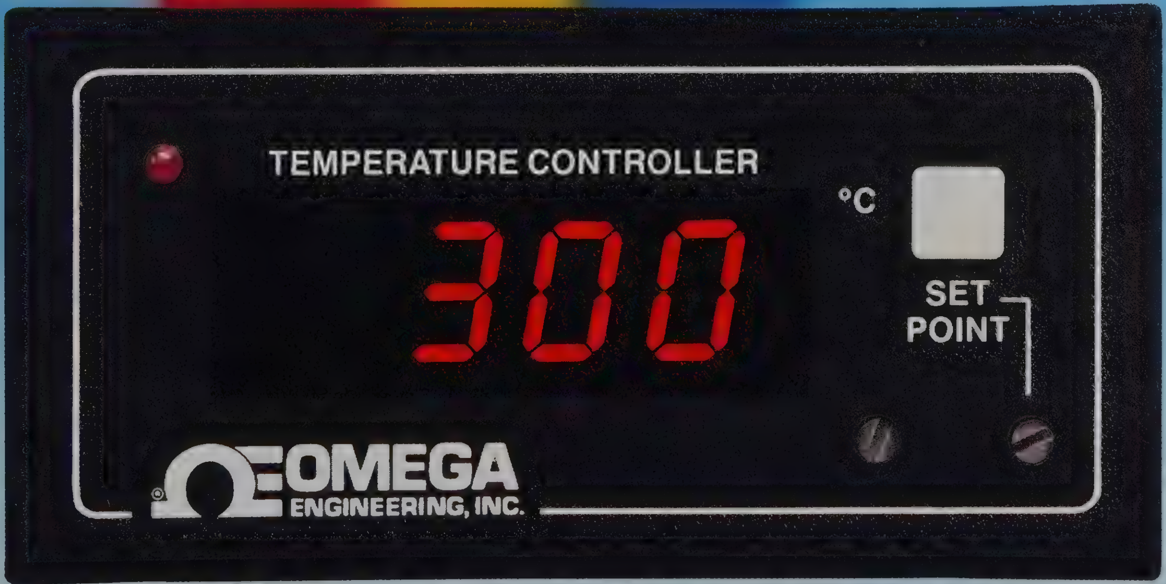
$199

TEMPERATURE CONTROLLER
300
°C
SET POINT
OMEGA ENGINEERING, INC.
OMEGA STAMFORD CT

Probe not included
See **section D**

Typical Applications

Food Processing
Baking Ovens
Commercial Frying and Cooking
Industrial Refrigeration
m and Print ocessing
lcanizing Equipment
ens
nall Furnaces
astic and Paper ckaging
chines
minating Presses
cuum Forming
b and armaceutical
ironmental ambers
stillation Equipment
erilization Equipment


TEMPERATURE CONTROLLER
300
°C
SET POINT
OMEGA ENGINEERING, INC.

Shown Actual Size

Solid State Temperature Controllers Series 300

NEW!

⅛ DIN Package

TEMPERATURE CONTROLLER
300
°C
SET POINT
OMEGA ENGINEERING, INC.

$199

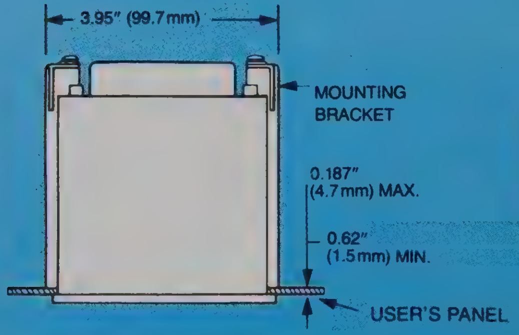
Heavy Duty Mounting Brackets

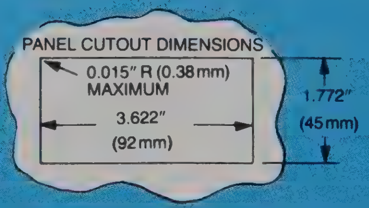
RANGES AVAILABLE

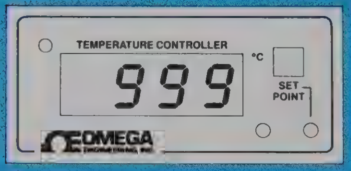
Model	Sensor Type	Range	Resolution	Price
CN300 JC	J	−100° to 760°C	1°C	$199
CN300 JF		−100° to 1400°F	1°F	
CN300 KC	K	−50° to 1200°C	1°C	
CN300 KF		−50° to 1999°F	1°F	

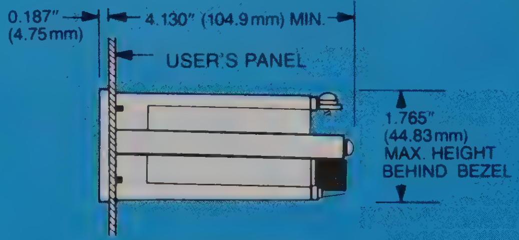
HOW TO ORDER

Specify by Model Type: For example, a CN300JC Controller is a type J thermocouple input, with a Celsius range of −100° to 760°C.


3.95″ (99.7 mm)
MOUNTING BRACKET
0.187″ (4.7 mm) MAX.
0.62″ (1.5 mm) MIN.
USER'S PANEL


PANEL CUTOUT DIMENSIONS
0.015″ R (0.38 mm) MAXIMUM
3.622″ (92 mm)
1.772″ (45 mm)


TEMPERATURE CONTROLLER
999
°C
SET POINT
OMEGA


0.187″ (4.75 mm)
4.130″ (104.9 mm) MIN.
USER'S PANEL
1.765″ (44.83 mm) MAX. HEIGHT BEHIND BEZEL

Specifications

Input

Thermocouples: Type J & K

Max. thermocouple lead resistance: 100 ohm for rated accuracy

Cold Junction Compensation: Automatic-electronic

Thermocouple break protection: Built in, upscale on open sensor

Accuracy: ± 0.5% of span

Common mode rejection: 120 dB

Series mode rejection: 100 dB at 50/60 Hz

Output

Relay: SPDT, 8 amps resistive at 120 V ac 4 amps resistive at 240 V ac

Recorder: 1 mV per °C

Adjustments

Manual Reset: Adjustable

Proportional Band (gain): Factory preset at 3.5% of span

Cycle Time: Factory preset at 20 seconds nominal

Display and Indications

Temperature: 0.56″ Super efficient LED display 1°C or F resolution

Set Point: Push to set button

Output: LED indicates relay energized

Set point

Resolution: 1°C or F

Repeatability: 0.1% of span ±1 digit

Adjustment: By 15 turn pot.

Power: 120/240 V ac (±15%), 50/60 Hz, less than 2 watts

Environmental & Physical

Operating temperature: 32° to 104°F (0° to 40°C)

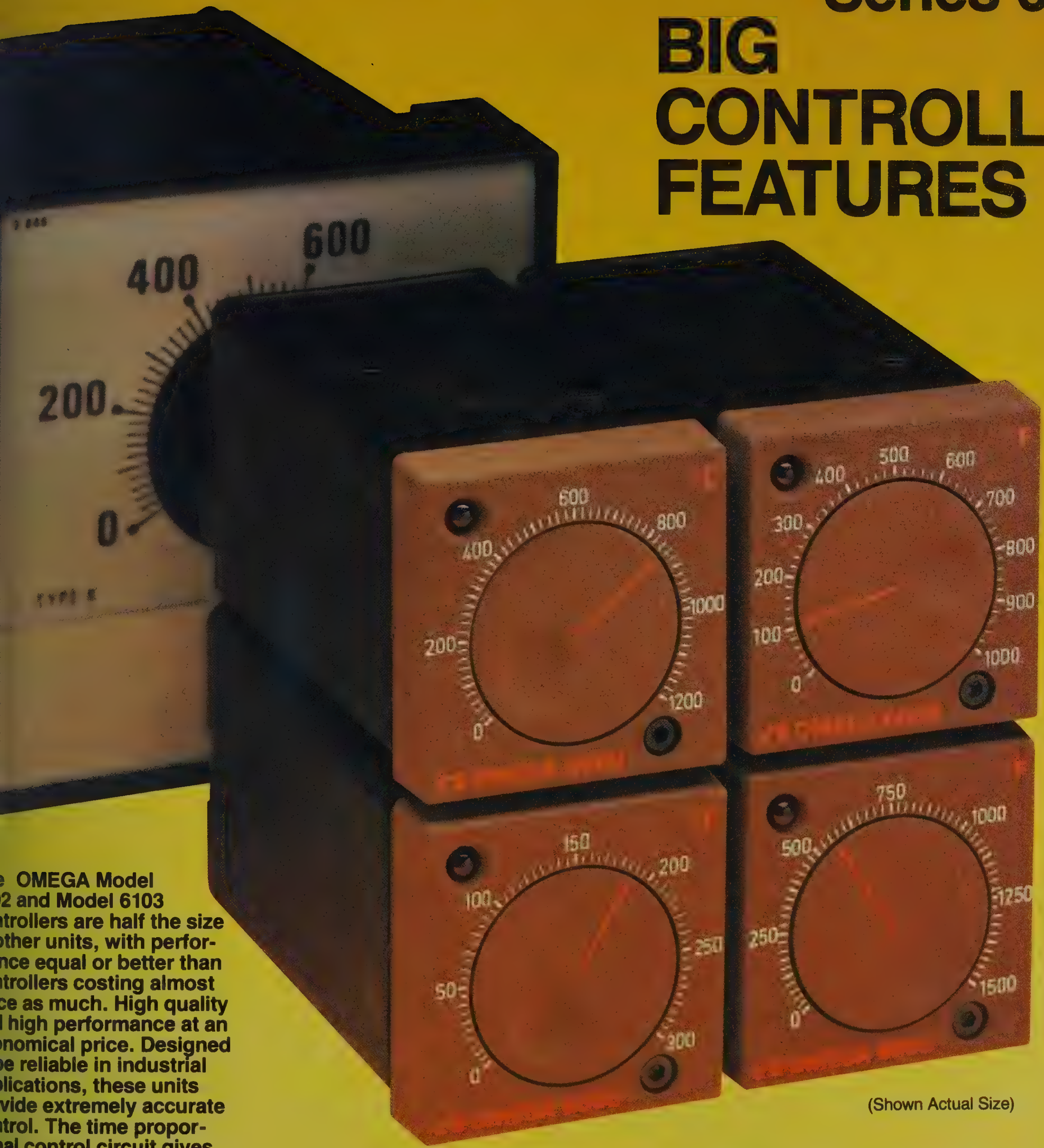
Weight: 0.88 lb (0.4 kg)

Dimensions: H: 1.772″ (45 mm) × W: 3.622″ (92 mm) × D: 4.130″ (105 mm)

Temperature Controllers

Series 6100

BIG CONTROLLER FEATURES ...



600
400
200
0
TYPE K
600
800
400
1000
200
1200
0
500
600
400
700
300
800
200
900
100
1000
0
150
200
100
250
50
300
0
750
1000
500
1250
250
1500
0

(Shown Actual Size)

e OMEGA Model
2 and Model 6103
ntrollers are half the size
other units, with perfor-
nce equal or better than
ntrollers costing almost
ce as much. High quality
l high performance at an
onomical price. Designed
be reliable in industrial
plications, these units
vide extremely accurate
ntrol. The time propor-
nal control circuit gives
curate, reliable control
h minimum overshoot.
lt-in power feedback
omatically compensates
variations in heater
wer which could be
used by voltage
ctuations.
e controllers are avail-
e in Type J, K, and S ther-
couple and platinum RTD
dels with temperature
ges up to 1600°C.

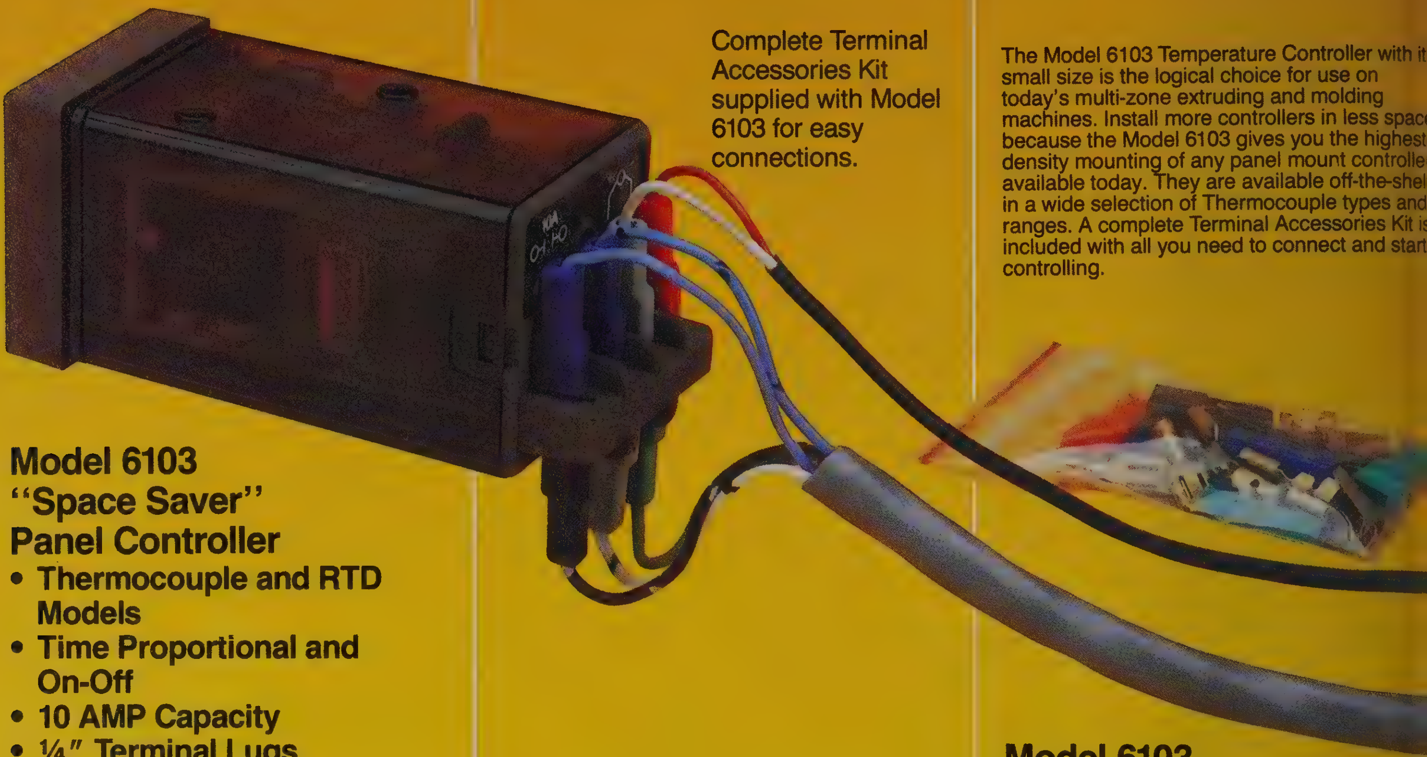
... in a new small package

- Thermocouple and RTD models
- Time proportional and on-off
- 10 amp capacity
- Compact—less than 2 inches square!
- Plug-in or panel mount
- High stability and control accuracy

Prices start at **$110**

Temperature Controllers

Series 6100
LOW COST SPACE-SAVING SYSTEM



Complete Terminal Accessories Kit supplied with Model 6103 for easy connections.

Model 6103
"Space Saver"
Panel Controller

- **Thermocouple and RTD Models**
- **Time Proportional and On-Off**
- **10 AMP Capacity**
- **¼" Terminal Lugs**

The Model 6103 Temperature Controller with it small size is the logical choice for use on today's multi-zone extruding and molding machines. Install more controllers in less spac because the Model 6103 gives you the highest density mounting of any panel mount controlle available today. They are available off-the-shel in a wide selection of Thermocouple types and ranges. A complete Terminal Accessories Kit i included with all you need to connect and start controlling.

Model 6103

$110

Model 6102
"Socket Mount"
Controller

- **Thermocouple and RTD Models**
- **Time Proportional and On-Off**
- **10 AMP Capacity**
- **11 Pin Connector**

The Model 6102 Temperature Controller is one of OMEGA's lowest cost units with all the features of big controllers. Packaged in a new small size to save you space and money. Model 6102 Controllers plug into an unbreakable nylon socket which may be mounted individually or snapped on to OMEGA's NEW mounting track. The unbreakable nylon socket and mounting track make installations in chassis, control panel and O.E.M. applications fast and easy using a minimum of space.

The Model 6102 is supplied as a complete system with socket.

Replacement Socket is availa as Part #6102-S $7

Model 6102

$115

Temperature Controllers

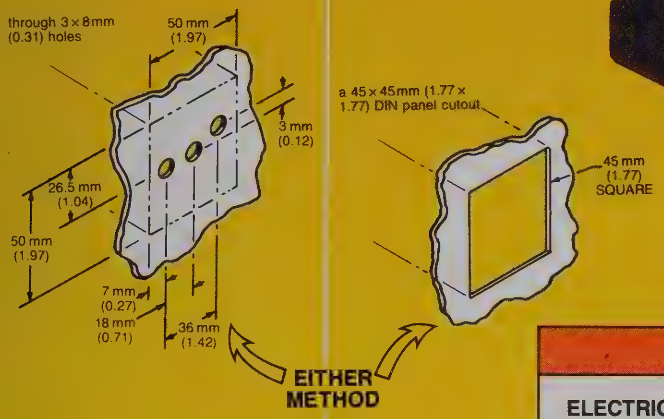
Series 6100

RANGES AVAILABLE

Type	Range	Socket Mount Style $115	Quick Disconnect $110
J	0-300°F 0-500°F 0-1000°F 0-300°C	6102-J-0/300°F 6102-J-0/500°F 6102-J-0/1000°F 6102-J-0/300°C	6103-J-0/300°F 6103-J-0/500°F 6103-J-0/1000°F 6103-J-0/300°C
K	0-500°F 0-1000°F 0-1500°F 0-1200°C	6102-K-0/500°F 6102-K-0/1000°F 6102-K-0/1500°F 6102-K-0/1200°C	6103-K-0/500°F 6103-K-0/1000°F 6103-K-0/1500°F 6103-K-0/1200°C
S	0-1600°C	6102-S-0/1600°C	6103-S-0/1600°C
RTD	0-600°C	6102-RTD-0/600°C	NOT AVAILABLE

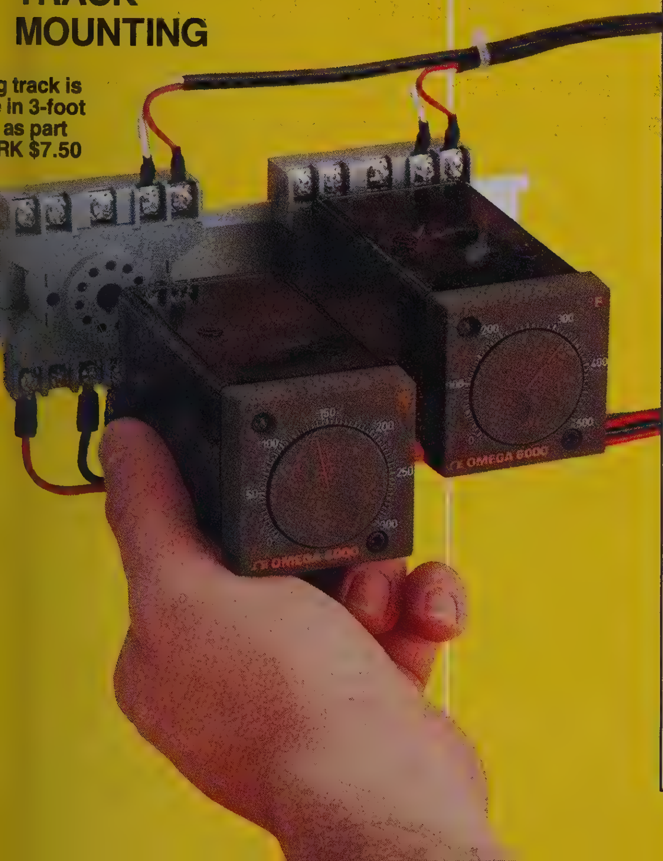
o Order: Simply specify the model number above, i.e., 102-J-O/300°F at $115.

CUSTOM PANELS AVAILABLE



EW! TRACK MOUNTING

g track is
in 3-foot
as part
RK $7.50



SPECIFICATIONS

ELECTRICAL	
Supply voltage	115 V −15% +20%—50-60 Hz
Power consumption	2 VA
Output	10 amp mechanical relay, SPST Contacts
CONTROL	
Calibration accuracy	±2% of scale span or 4°C, whichever is the greater (from 10-90% of scale span).
Linearity-resolution	Linearity 6%, resolution 1% max., of scale span (dependent on sensor/range).
Control accuracy	±0.4% of full scale span at an ambient of 22°C ±2°C, at rated line voltage, after 30 minutes settling time.
CONTROL MODES	
Time proportional	Proportional with accelerated response to temperature variations.
ON/OFF	See Owners Manual to convert to ON/OFF MODE.
INPUT	
Thermocouple	J, K and S
External resistance	Max. 100 ohms
Cold junction compensation	Automatic
Common mode	Negligible effect up to 270 V 50-60 Hz.
Series mode	Negligible effect up to scale spread mV equivalent at 50-60 Hz.
Sensor break protection	Automatic upscale
RTD Sensor	100 OHM Platinum α = 0.00385
GENERAL	
Indication	A high brightness LED—shows Heat ON.
Ambient temperature	0-50°C (32-122°F)
Suppression	Filtering is provided for line and sensor input interference.
Dimensions and weight	H: 1.89″ (48 mm) × W: 1.89″ (48 mm) × D: 3.86″ (98 mm), depending on model; 7 oz. (200g)
Construction	Flame-retardant polycarbonate and ABS. Bezel and knob coated with Nextel.
Connections	¼″ standard terminal lugs or 11 pin connector.

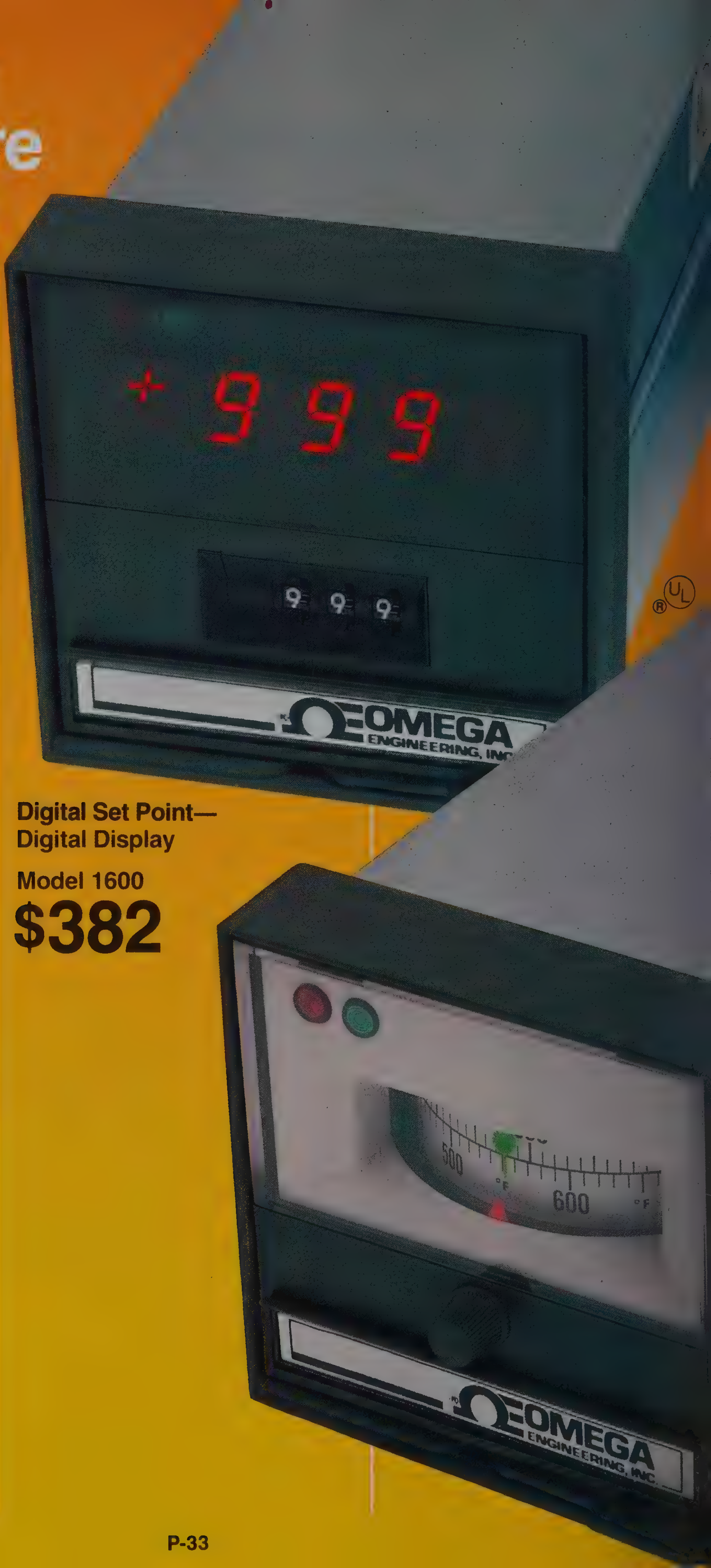
Solid State Temperature Controllers

High Performance Models

Series 1600
Digital Display—
Digital Set Point

Series 1500
Full Scale Analog Display

Series 1400
High Resolution Display


+999
999
OMEGA ENGINEERING, INC.
500
600
°F
OMEGA ENGINEERING, INC.

Digital Set Point—
Digital Display

Model 1600

$382

OMEGA ENGINEERING, INC.
MADE U.S.A.
°F
°C
UL

Full Scale Analog Display

igh Resolution Display

Models 1400 and 1500

$212

Control Features

Automatic 3-Mode

Fully automatic 3-mode control with unique Rate and Reset Windup Inhibit circuits that prohibit temperature overshoots. Excellent control for the more demanding application where fine tuning is essential.

3-Mode

3-Mode controllers with adjustable proportional band and jumper selectable time constants for Rate (Derivative) and automatic Reset (Integral). Same Rate and automatic Reset circuitry as fully automatic 3-mode controller. Ideally suited for use where processes remain virtually unchanged.

Time Proportional

Time Proportional, On/Off and Limit models are available in many set point/readout configurations. These instruments provide optimum price/performance for those applications where Integral and Derivative control action is not required.

Features

- The widest selection of set point/readout configurations.
- The most comprehensive group of control output types.
- Advanced Rate and Reset Windup Inhibit circuitry.
- One of the largest LED displays in the industry.
- Adjustments up front for easy access.
- A plug-in chassis that removes in seconds.
- Rugged extruded aluminum case and cast aluminum bezel.
- Linearized scales on analog indication models.
- LED indicator lights for Heat On, Heat Off, Cooling, Alarm.
- The largest selection of individual ¼ DIN controller models to choose from.

Solid State Temperature Controllers

Series 1600

**Digital Display—
Digital Set Point**

- **Thermocouple and RTD Input**
- **Time Proportional**
- **10 Amp Relay Standard**
- **10 or 20 Amp Triac Available**
- **Set Point Accuracy ±0.5% of Span**
- **Single and Dual Set Point**

The OMEGA Series 1600 Digital Controllers combine high accuracy with an easy-to-read digital display. Process temperature is quickly and efficiently set using the simple mechanical thumbwheels.

The FULLY ADJUSTABLE 3-MODE Model 1622 features an extremely effective Derivative function (Rate), which is developed at the sensor input circuitry. Since the Rate feature is always active, it helps prevent overshoot from start-up to process control temperatures. The Reset Windup Inhibit functions as the process temperature approaches either edge of the proportional band. It allows the instrument to control the process as the temperature enters the proportional band without over or undershooting the set point.

The 3-MODE CONTROLLER versions (Models 1606 and 1612) provide full 3-mode control with jumper selectable time constants designed for optimum control of either a slow or fast reacting process. The Derivative (Rate) may be eliminated by placing its jumper in the OFF position.

The TIME PROPORTIONAL version features the latest in solid state design plus manual Reset adjustment.

+ 999
999
OMEGA ENGINEERING, INC.

$382
(Model 1600)

Model	Main Output Description	Price
1600	On/Off Control	$382
1602	Time Proportional	399
1601	High Limit Control	382
1603	Low Limit Control	382
1612	Time Proportional—3-mode	471
1606	4-20 mA—3-mode	471
1622	Time Proportional—Fully Adjustable	568

For Dual Set Point Options see page P-39

OMEGA ENGINEERING, INC.
ADE U.S.A.
°F
0°C
J(I/C)

Solid State Temperature Controllers

Series 1500

Full Scale Analog Display

- **Thermocouple and RTD Input**
- **Easy-to-Read Display**
- **10 Amp Relay Standard**
- **10 or 20 Amp Triac Available**
- **Set Point Resolution ±0.1% of Span**
- **Single and Dual Set Point**

$212
(Model 1500)

Model	Main Output Description	Price
1500	On/Off	$212
1502	Time Proportional	229
1501	High Limit Control	212
1503	Low Limit Control	212
1512	Time Proportional—3-mode	349
1522	Time Proportional—Fully Adjustable	398

r Dual Set Point Options see page P-39

The OMEGA Series 1500 Full Scale Analog Display Controllers allow constant monitoring from process start-up to controlling set point temperature.

The FULLY ADJUSTABLE 3-MODE Model 1522 features an extremely effective Derivative function (Rate), which is developed at the sensor input circuitry. Since the Rate feature is always active, it helps prevent overshoot from start-up to process control temperatures. The Reset Windup Inhibit functions as the process temperature approaches either edge of the proportional band. It allows the instrument to control the process as the temperature enters the proportional band without over or undershooting the set point.

The 3-MODE CONTROLLER Model 1512 provides full 3-mode control with jumper selectable time constants designed for optimum control of either a slow or fast reacting process. The Derivative (Rate) may be eliminated by placing its jumper in the OFF position.

The TIME PROPORTIONAL version features the latest in solid state design plus manual Reset adjustment.

Solid State Temperature Controllers

Series 1400

High Resolution Display

500
°F
600
°F
OMEGA
ENGINEERING, INC.

- **High Resolution Direct Reading Scale**
- **10 Amp Relay Standard**
- **10 or 20 Amp Triac Available**
- **Repeatability ±0.1% of Span**
- **Time Proportional, On/Off and Limit Models**
- **Rugged All Metal Case**

The OMEGA Series 1400 High Resolution Display Controllers have a unique drum style set point dial which provides high resolution and accuracy while displaying 30% of the controller's range.

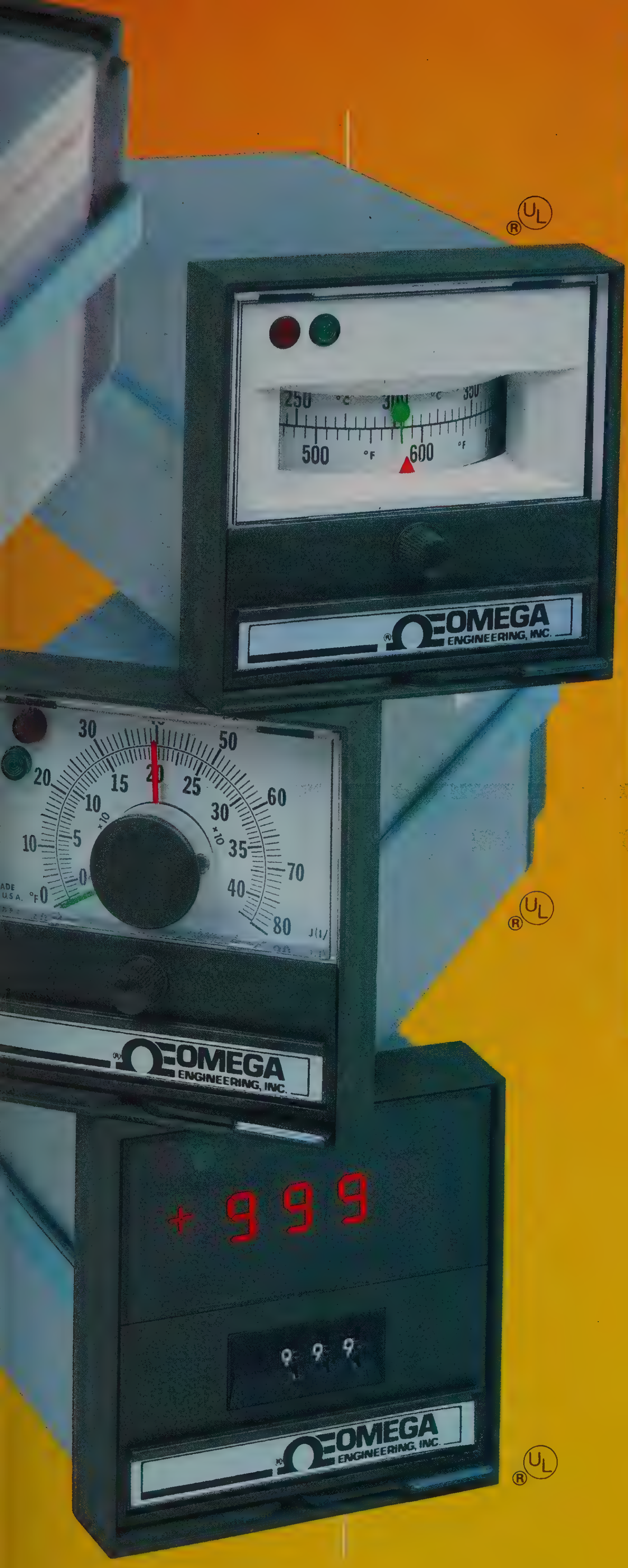
The 3-MODE CONTROLLER Model 1412 provides full 3-mode control with jumper selectable time constants designed for optimum control of either a slow or fast reacting process. The Rate (Derivative) may be eliminated by placing its jumper in the OFF position.

The TIME PROPORTIONAL version features the latest in solid-state design plus manual Reset adjustment.

$212
(Model 1400)

Model	Main Output Description	Price
1400	On/Off Control	$212
1402	Time Proportional	229
1401	High Limit Control	212
1403	Low Limit Control	212
1412	Time Proportional—3-mode	349

For Dual Set Point Options see page P-39



Ranges

Digital Models

Type	Range	All Series 1600	1606 1612 1622
J	0 to 999°F	*	
	0 to 899°C	*	*
K	0 to 1999°F	*	*
	200 to 1199°C		*
T	0 to 299°C	*	*
C	0 to 3999°F		*
R	0 to 2999°F		*
S	0 to 999°C		*
	0 to 2999°F		*
RTD (requires option 9451 add $25)	0 to 99°C α = **.00385**	*	*

Analog Models

Type	Range	1400	1500
J	0 to 400°F −18 to 205°C	*	*
	0 to 800°F −18 to 425°C	*	*
	0 to 1600°F	*	*
K	0 to 1600°F	*	*
	0 to 2500°F −18 to 1370°C	*	*
T	−300 to 300°F −184 to 148°C	*	*
C	1500 to 3500°F 820 to 1930°C		*
R	0 to 3000°F −18 to 1648°C		*
S	0 to 1600°C 32 to 2912°F		*

How To Order:

(1) Specify Model

(2) Second Set Point Options page P-39

(3) Thermocouple Type or RTD

(4) Range in °F or °C

(5) List all Options

Example:

1512 -	1 -	K -	0/2500°F -	9460
(1)	(2)	(3)	(4)	(5)

The Catalog number signifies a Chromel-Alumel, 3-mode time proportional controller, with a high alarm second set point, 0° to 2000°F range and On/Off power switch option 9460.

Solid State Temperature Controllers

Specifications

—Series 1400, 1500, and 1600

Set Point Accuracy

3-Mode and Fully Adjustable Models:
±1% Typical of Span over central 80% of span.

Time Proportional, On/Off and Limit Models:
±1.5% Typical of Span over central 80% of span.

Operating Conditions

Ambient temperature 0-50°C line voltage +10% to −15% from 120/240 V ac at 50-60 Hz; T/C external resistance 0-100 ohms max.; Humidity 0-70% RH max.

Set Point Resolution: ±0.1% of span (analog), 1°C (digital).

Ambient Temperature: −10°C to 55°C (50% for digital indication models).

Repeatability: ±0.1% of span.

Cold Junction Compensation: Standard, upscale.

Common Mode Rejection: 120 dB to 240 V ac at 50-60 Hz.

Normal Mode Rejection: 60 dB to 50-60 Hz.

Control Adjustments 1522, 1622

Proportional Band (Gain): Adjustable 3% to 40% of span.

Automatic Reset (Integral): Adjustable 0.15 to 15 minutes (6 to 0.06 repeats per minute).

Rate (Derivative): Adjustable 0 to 5 minutes.

Cycle Time: Adjustable 2 to 60 seconds.

Control Adjustments XX12, 1606

Proportional Band (Gain): Adjustable 3% to 40% of span.

Automatic Reset (Integral): Jumper selectable: 5 or 15 minutes (0.2 or 0.07 repeats per minute).

Rate (Derivative): Jumper selectable: Off, 1 minute or 3 minutes.

Cycle Time: Jumper selectable: 2, 12 or 36 seconds.

Control Adjustments *140X, 150X, 160X

Proportional Band (Gain): 3% fixed.

Manual Reset (Time Proportioning Models): Adjustable 0% to 100% at Set Point.

Cycle Time: 12 seconds (fixed).

Dimensions: Standard DIN/NEMA
Cutout: 3.622″ × 3.622″ (92 mm × 92 mm)
Bezel: 3¹⁵⁄₁₆″ (100 mm) square
Depth: 7⅛″ (181 mm)

Options

Option No.	Description	Available With	Price
9439	Local/Remote Set Point	1606, 1612, 1622	$88
9440-( )	Recorder Output Suffix Range -A 0-1 mA -B 1-5 V dc -C 0-5 V dc	Local/Remote Switch inside unit.	$69
9441-( )	Local/Remote Set Point Controlled By Computer Suffix Range -A 0- 5 V dc -B 1- 5 V dc -C 4-20 mA -D 0- 8 V dc -E 0-10 V dc -F 0- 2 V dc	1606, 1612, 1622 Returns to Local if Computer input is removed. Local/Remote Switch inside unit.	$95
9451	RTD Sensor Input	1602, 1606, 1612, 1622	$26
9456	Downscale Thermocouple Break Protection	All Models	N/C
9460	Built-In On/Off Power Switch	All Models Except XX01, XX03, and Second Set Point-4 Option	$16
9480	4-20 mA—Direct Acting, Output increases with increasing temperature input.	XX06. XX16	N/C
9483	10 Amp 240 V ac Output Relay	All Models	N/C
AA0880	Cover For Rear Terminals (Conduit Housing Also For Surface Mounting)	All Models	$56
04A	10 A Solid State Output (Triac)	XX00 Single Set Point XX12 Models Only.	$101
04B	20 A Solid State Output (Triac)	XX22 Single Set Point Models Only.	$101

Second Set Point Options

See "How To Order" page P-38

Description

- −1 **High Alarm** Tracks primary set point. Energizes and latches relay above alarm set point.
- −2 **Low Alarm** Tracks primary set point. Energizes and latches relay below set point.
- −3 **Deviation Band Alarm** Tracks primary set point. Energizes above or below the alarm set point.
- −4 **Process Alarm (as On/Off switch)** Relay energizes only above the alarm set point and is independently adjustable from primary set point.
- −7 **Proportional Cooling Output** Time proportioning relay output for extruder cooling.

Available With

	XX01 XX02 XX03	1522 1622	XX12 1606
High Alarm	$67	$ 88	$ 90
Low Alarm	67	88	90
Deviation Band Alarm	96	101	106
Process Alarm	96	101	106
Proportional Cooling Output	N/A	107	117

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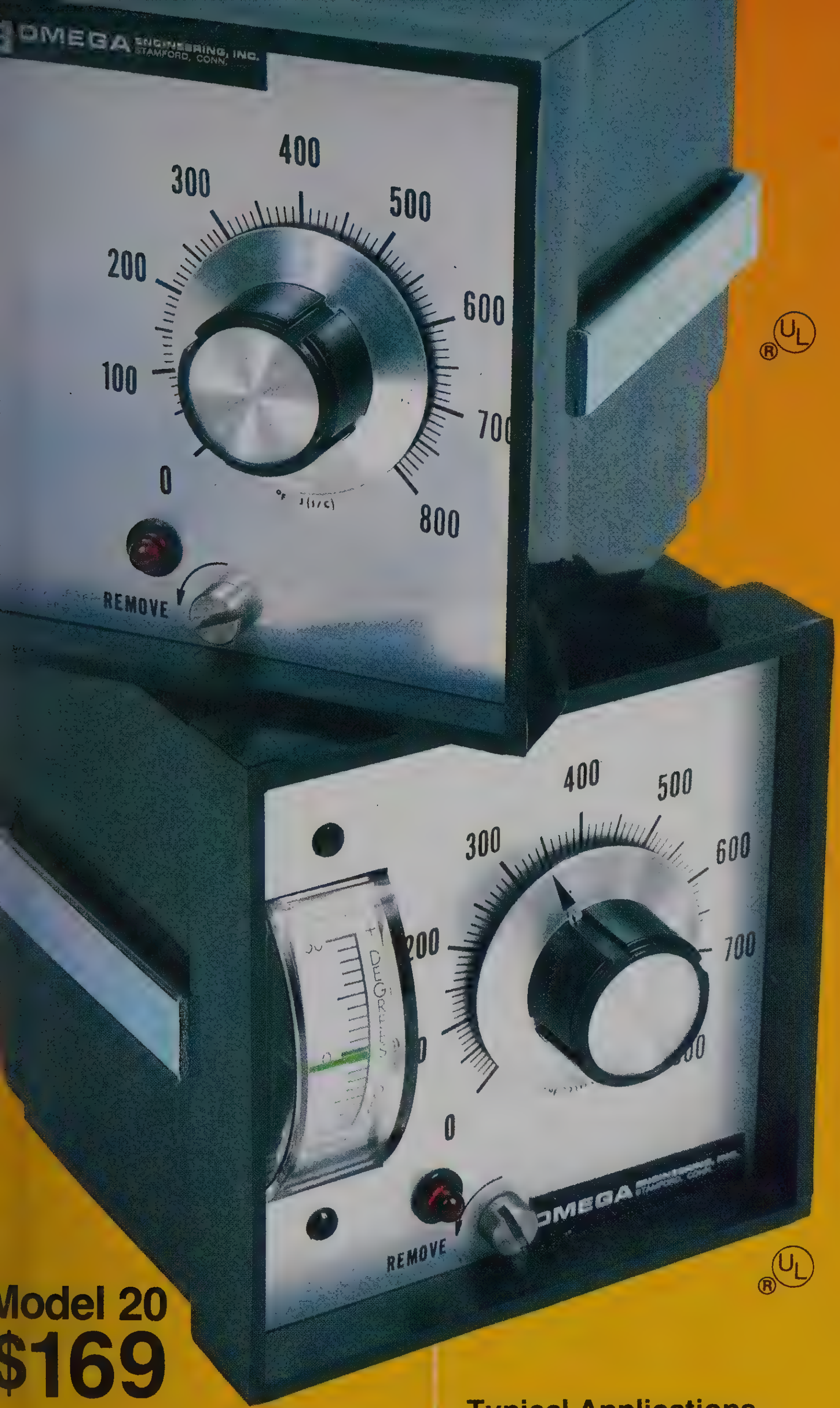
*Except 1606

Solid State Temperature Controllers

Series 20


OMEGA ENGINEERING, INC. STAMFORD, CONN.
0
100
200
300
400
500
600
700
800
REMOVE
DEGREES
OMEGA ENGINEERING, INC. STAMFORD, CONN.

lodel 20

$169

lodel 20 M

$185

eatures

- **Model 20—ON/OFF**
- **Model 22—Time Proportional**
- **Standard Ranges Available in °F and °C**
- **¼ DIN Case (92 mm)**
- **Thermocouple Distance from Controller Nearly Unlimited**
- **Set Point Scale Is 6½″ (165 mm) Long**
- **LED indicates Power to Load "On"**
- **Solid State Output**

Typical Applications

Food Processing
Baking Ovens
Commercial Frying and Cooking
Refrigeration

Industrial
Film and Print Processing
Vulcanizing Equipment
Ovens
Small Furnaces
Plastic and Paper Packaging Machines
Laminating Presses
Vacuum Forming

Lab and Pharmaceutical
Environmental Chambers
Distillation Equipment
Sterilization Equipment

OMEGA's Series 20 low cost thermocouple sensing temperature controllers are available in both non-indicating and deviation meter models. All popular thermocouple calibrations and temperature ranges can be specified. The controller has cold junction compensation and thermocouple break protection.

The Series 20 controllers have an accuracy of ± 1.5% (typical) over the central 80% of span and a 3 A solid state Triac output for controlling 120 or 240 V ac resistive loads. Time proportional models have a fixed 2.5% bandwidth. Adjustable bandwidth is optionally available.

Other options include a water/dust resistant cover, 3 A fuse and 10 and 15 A Triac outputs. Compact ¼″ DIN size (6.3 mm), Series 20 controllers require a 3⅝″ (92 mm) square panel cutout and extend only 3¼″ (82 mm) behind the panel.

Model 9371 SPLASH COVER

$43

The "9371" splash cover fastens securely over the front of the controller to effectively protect it from dust and water found in severe operating environments.

Must be ordered with instrument.

Solid State Temperature Controllers

Series 20

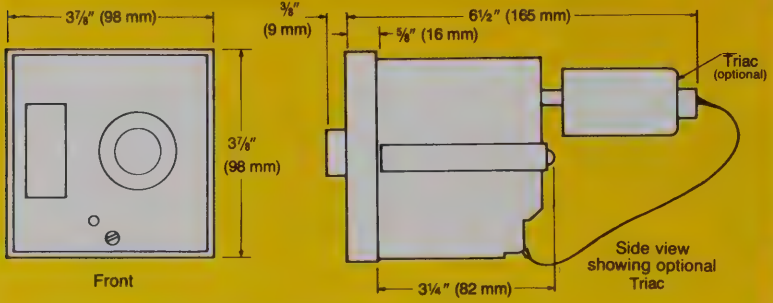
SELECT EITHER MODEL
$169

Model/Accessory Designations

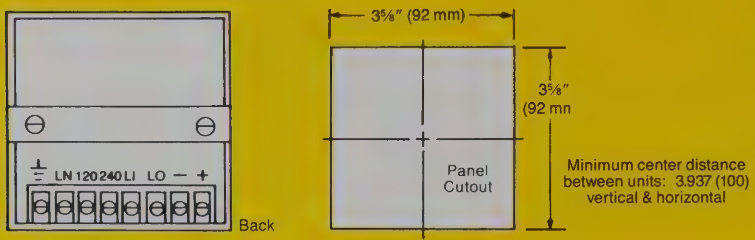
Model 20—On/off Control
Model 22—Time Proportional Control

Specifications

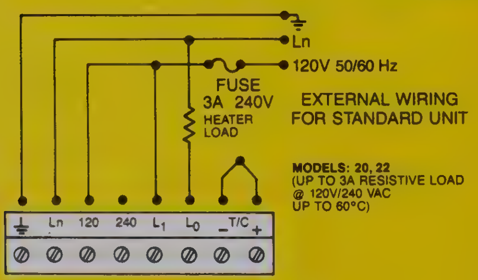
Set Point Accuracy: ±1.5% (typical) over central 80% of span.
Set Point Repeatability: ±0.5% of full scale value.
Bandwidth: 2.5% fixed (proportional model only).
Temperature Stability: Typical: 6 μV/°F from 32°F to 140°F ambient.
Line Voltage Stability: Typical: 0.5% of full scale at 120/240 V ac at +10% - 15% of line voltage.
Common Mode Rejection: No significant effect at 240 V, 60 Hz.
Thermocouple Break Protection: Upscale is standard, downscale is optional.
Line Supply Voltage: 120 or 240 V ac 50-60 Hz.
Meter (Optional) Accuracy: ±1% of instrument full scale.
Weight: Approximately 1 lb. (0.45 kg)
Cold Junction Compensation: Standard.
Maximum External T/C Resistance: 100 ohms.
Cycle Time: 10 to 12 sec. standard.
Solid State Triac Output: SPST at 120 V ac or 240 V ac, 20 amp surge, 3 amps at 60°C ambient, 5 amps at 45°C ambient, 6 amps at 25°C ambient, 40 mA holding current.
On-Off Differential: 0.5% of span.
Power Consumption: Approximately 2 V A.
Optional: Fused Output.
LED: Indicates power on to load.


3⅞" (98 mm)
⅜" (9 mm)
6½" (165 mm)
⅝" (16 mm)
Triac (optional)
3⅞" (98 mm)
Front
Side view showing optional Triac
3¼" (82 mm)

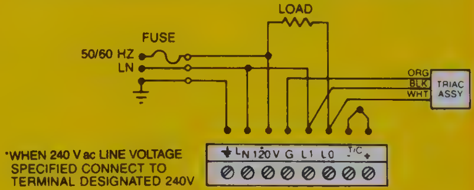
Outline Drawings Series 20


LN 120 240 L1 LO − +
Back
3⅝" (92 mm)
3⅝" (92 mn
Panel Cutout
Minimum center distance between units: 3.937 (100) vertical & horizontal

Wiring Diagrams


Ln
120V 50/60 Hz
FUSE 3A 240V
HEATER LOAD
EXTERNAL WIRING FOR STANDARD UNIT
MODELS: 20, 22 (UP TO 3A RESISTIVE LOAD @ 120V/240 VAC UP TO 60°C)
Ln 120 240 L1 L0 T/C − +

EXTERNAL WIRING FOR 10 & 15 AMP TRIAC MODELS


LOAD
FUSE
50/60 HZ
LN
ORG
BLK
WHT
TRIAC ASSY
LN 120V G L1 L0 T/C − +

*WHEN 240 V ac LINE VOLTAGE SPECIFIED CONNECT TO TERMINAL DESIGNATED 240V

Option	Description	Available with	Price
M	Meter (optional)	All Models	$27
9338	Fuse (optional)*	All Models	7
9339	Adjustable band and Manual Reset	Model 22	16
9342-[ ]	15 A solid state switch (Triac)*	Specify 120 V ac or 240 V ac line voltage	70
9371	Water/dust resistant cover	All Models	43
9340	208/240 V ac Power input version	All Models	11
9375-[ ]	10 A Solid state switch (Triac)*	Specify 120 V ac or 240 V ac line voltage	49
AA0880	Cover for rear teminals (conduit housing also for surface mounting). Should not be ordered with options 9375 or 9342.		56

*PLEASE NOTE: Fuse option (M9338) will not protect load or solid state switches when used with options M9342 (15 amp Triac) and M9375 (10 amp Triac). These options should not be ordered together.

"Ranges"—Series 20

°F Range	T/C Type	Meter Divisions
−100 to 350	T	2°
0 to 300*	J	2°
0 to 500*	J	5°
0 to 800*	J	5°
0 to 1000	J	10°
500 to 1500	K	10°
0 to 1800	K	20°
0 to 2500	K	20°
°C Range	**T/C Type**	**Meter Divisions**
0 to 300	J	2°
0 to 800	K	5°
0 to 1200	K	10°

*Most Popular Ranges

How To Order:

1. Specify Model 20 or 22
2. Specify calibration J, K, or T
3. Specify range and scale (either °C or °F)
4. List all options

Example: Model 22J-0/500°F with Options M, 9338 and 9371. This signifies an Iron-Constantan, Time Proportional Controller, 0° to 500°F Range with deviation meter, fuse, and water/dust resistant cover options.

Temperature Controllers

X100
6
8
10
12
14
16
18
20
K
OMEGA ENG.
STAMFORD, CONN.
MODEL 50
ON-OFF / LIMIT CONTROL
MADE IN U

Thermocouple
Thermistor
RTD

- **Electronic Indicating**
- **Solid State Plug-In**
- **Single and Dual Set Point**

For temperature control of plastics and rubber machinery, ovens, furnaces, kilns, environmental chambers, packaging machines, soldering machines and other industrial equipment requiring exacting temperature control

Prices start at $220

Operation

The input voltage from the thermocouple is automatically compensated for ambient temperature changes and is applied o the input of an integrated circuit amplifier; the output drives a full range indicator having a scale length of 5¾ inches. The high output from the amplifier allows the use of a very rugged ndicator. The amplified signal is at the same time compared o a highly stable reference voltage corresponding to the set point temperature. The reference signal is obtained from a potentiometer slide wire coupled to the set point indicator and s manually set to the desired temperature set point through a push-to-set knob. The differential voltage between the thermocouple signal and the set point reference voltage is urther amplified and is used to control the output relay, which controls power to the load. Models available for Thermocouples, Thermistors and RTD's.

Features

Full Plug-In construction allows the entire control unit to be removed from its housing without disturbing the customer wiring on the back of the housing. The housing stays in the panel and another control unit having a different range may be plugged in. A single captive jack screw located on the front of the control automatically disengages the rear plug and finger grips molded nto the bezel allow quick withdrawal of control unit.

Plug-In Relay is standard and is a type that can be purchased ocally in any part of the world. It is rated at 10 amperes. An optional solid state relay is offered. See "Options."

Full-Time, Full Scale Indication is provided. Both the ndicating and set points are on the same scale. No "partial" or deviation indication. True temperature is always indicated on the large 5¾" long scale without restriction. The set point is also continuously displayed. Colors and size of set pointer and ndicating pointers allow distant viewing of their relationship at a glance.

Thermocouple Break Protection is standard. No extra wiring is required. Upon break, process shuts down (relay de-energized) and the indicator reads full scale.

Heating and Cooling lights are provided. Limit models also feature an amber alarm light which flashes a limit warning.

Wiring is made extremely convenient. Large screw terminals are provided on the rear of the housing. Wiring does not have to be removed to unplug control unit. An optional rear terminal enclosure is available. See option list.

Specifications

Input: Thermocouple (RTD and Thermistor also available)

Accuracy: ±0.5%

Proportioning Band: 2% F.S. Proportioning Models only.

On-Off Differential: As good as 0.2% of range. On-Off Models only. Larger differential can be supplied on special order. See option list.

Scale Length: 5¾"

Indicator Accuracy: ±1.0%

Maximum Thermocouple Resistance: 200 Ohms with rated accuracy.

Supply Voltage: 120/208/240 V.A.C., 50/60 Hz., by terminal selection.

Acceptable Supply Variation: 85 to 110% of supply voltage.

Control Relay: Plug-in, 10A (120 v.a.c.); 5A (240 v.a.c.) non-inductive. Second relay in three position models rated at 5A. (120 v.a.c.) 2½ A. (240 v.a.c.) non-inductive. Both relays have single pole, double throw contacts.

Ambient Temperature Range: 35 to 140°F maximum.

Thermocouple Break Protection: Built-in, fail safe, if thermocouple breaks.

Weight: Approx. 3 lbs.

Proportional and Limit Controller
for Themocouples –
Thermistors — RTD'

Three Wire Line Cord
Available. Add **$6.**

Single Set Point Controllers

All single set point controllers have two pilot lights. Red indicates heat on, green indicates heat off. In addition, the Model 50 limit controller has an amber alarm light which flashes upon limit condition.

Model 49 Proportioning Control Price: **$220**

This model automatically proportions the relay on and off time in accordance with the demand of the process. The proportioning action occurs within a band around the set point called the proportioning band. The Model 49 band width is 2% of scale range. Within this band, various on time and off time ratios occur. At the very edge of the band, below set point, power to the heaters is on 100% of the time. As the controlled temperature enters the proportioning band, the on time decreases steadily until the upper edge of the band is reached, where the on time would be 0%. In addition, the proportioning band is automatically shifted to anticipate temperature changes. When controlled temperature is rising, the band is shifted down scale to anticipate an early turn off. If the controlled temperature is falling, the band is shifted up scale for anticipated turn on. The shifting of the band and the adjusted on to off time ratio allow the controller to proportion the heat on and off **without** a change in the actual controlled temperature. In this way uniform process temperature control is achieved.

While most controls of this type have a fixed or manually adjusted proportioning time cycle, this model features automatic rate action which varies the cycle time in accordance with the demands of the process.

In all proportioning controllers the controlled temperature can stabilize at any temperature within the proportioning band. If this temperature should be either above or below the actual temperature as set with the set pointer, this is called "Offset."

The Model 49 is provided, as standard, with an "Offset Correct" adjustment so that control may be adjusted to the exact temperature set on the controller. An option is available for "**Automatic** Offset Correct." See option list. (Three mode controller).

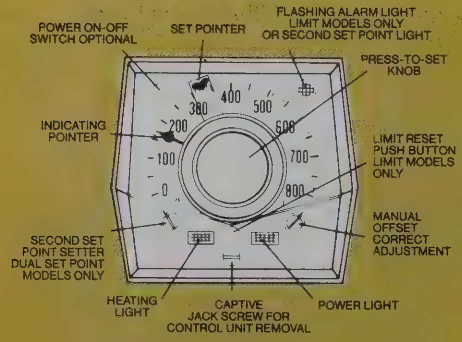
Model 50 On-Off or Limit Price: **$230**

This model is unique in that it is four controllers in one; heating On-Off, cooling On-Off, High Limit or Low Limit. Control function is selected by jumpers. The heating On-Off control function simply turns the power on and off to the heating load. The cooling On-Off turns power on and off to the cooling means. The on-off differential is 0.1% of the scale range.

In the High Limit function the control relay drops out upon a temperature rise to the set point and an amber limit light flashes a limit warning. A limit reset button is built-in (terminals are also provided for remote reset if desired) to reset the controller upon return to a temperature decrease below the set point. The control can also be used for heat treat furnaces requiring shut down at a preset temperature. Restarting for a new run is simply achieved by pushing the limit reset button.

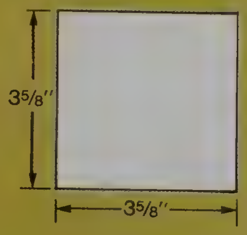
By selecting the Low Limit function, the control relay drops out upon a temperature decrease to the set point and the amber limit light flashes a warning. The control may be reset by depressing the limit reset button upon return to a temperature increase over the set point.

Controller Panel Arrangement


POWER ON-OFF SWITCH OPTIONAL
SET POINTER
FLASHING ALARM LIGHT LIMIT MODELS ONLY OR SECOND SET POINT LIGHT
PRESS-TO-SET KNOB
INDICATING POINTER
LIMIT RESET PUSH BUTTON LIMIT MODELS ONLY
MANUAL OFFSET CORRECT ADJUSTMENT
SECOND SET POINT SETTER DUAL SET POINT MODELS ONLY
HEATING LIGHT
CAPTIVE JACK SCREW FOR CONTROL UNIT REMOVAL
POWER LIGHT
400
500
300
600
200
700
100
800
0

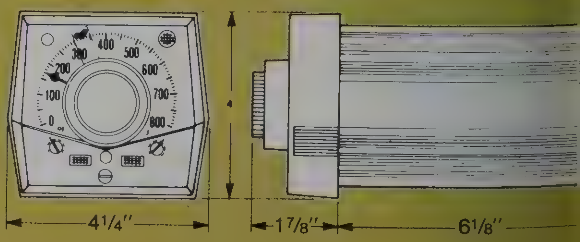
Dimensions

Controllers and Panel Cut-Out *(Same Panel Cut-Out For All Units)*



Controller —

Models 49 and 50



OMEGA ENG
STAMFORD
OMEGA
°F
x 100

Additional Controllers

Model 51 $385

10 Ampere Controller

Model 51 is a three-mode proportional temperature controller with a self contained triac power unit to handle all single phase resistive or inductive heating loads up to 10 amperes at 120, 208 or 240 VAC. It is a zero crossover type to reduce line voltage spikes and transients to an absolute minimum and prevent interaction between controllers. Extremely close control is achieved, since the controller supplies only enough power to the heaters to maintain the temperature set on the dial. Control is further enhanced by the reset and rate modes.

The reset mode features an exclusive Omega development which removes the reset mode until the temperature to be controlled is within the proportional band, eliminating reset windup, thereby allowing the process to cut back before the control temperature is reached (either in coming up to temperature or going down to a new temperature.) This feature automatically inhibits overshoot or undershoot. Reset is adjustable for 3, 6 or 10 minutes. The rate mode is automatic and anticipates sudden line, load or process upsets, applying immediate correction.

Heater life is extended by elimination of thermal shock. For full rated output, ambient temperature at the controller should not exceed 104°F.

Two pilot lights are built in. One indicates relative power to the load, while the other indicates power is applied to the control.

Model 52 $420

30 Ampere Controller

Model 52 is the same as the Model 51, but has a separate, remote surface mounting, power unit (only 7½" long x 4⅛" wide x 1⅝" high) rated at up to 30 amperes at 120, 208 or 240 VAC. It will handle all single phase resistive or inductive heating loads and is fused. For full rated output, ambient temperature at the power unit should not exceed 104°F.

Dual Set Point Controllers

All dual set point controllers have three pilot lights. Red and Green lights indicate the operation of the main set point and an amber light indicates the operation of the second set point.

Dual set point models (except Model **58**) have a second set point adjustment within a range of −10% to +10% of scale range relative to the main set point. If the main set point is changed thereafter, the second set point will follow and hold the same percentage relationship as originally set.

On Model **58** the two set points are fully adjustable from full overlap to 2% of scale range spread between set points (dead-band).

Consult factory for wide second set point adjustment (±20% — Option 848) and independently adjustable set points (Option 818)

Model 56 $275

Two On-Off Set Points

Model 56 has two On-Off control positions and operates two instrument control relays. The main control point is set, by means of press-to-set knob on the analog model or by means of the digital thumbwheel on the digital model, at any temperature on the scale. The applications for this model include high-low-off control where high heat is provided below both set points, low heat between set points and off above both set points.

Reversible motor operators on valves or dampers may also be controlled. The motor will drive the valve or damper toward opening below both set points. The motor will stop between set points and the motor will drive the valve or damper toward closing above both set points. This is called "floating" control.

Model 57 $285

Proportioning/On-Off Set Points

Model 57 is the same as the Model 56 but provides Proportioning Control on the main set point and On-Off control on the second. The Model 57 can be used for heating-cooling applications where proportioning heat control and on-off cooling control is required. Manual offset correct is standard, automatic is optional.

Model 58 $300

Proportioning/Proportioning Set Points

Model 58 is used where Proportioning heating and Proportioning cooling is desired. Plastics extruders using *blower cooling* would be an ideal application for this model. Manual offset correct is standard, automatic is optional.

Models 49 through 58
Most Popular Options and Ranges

Option #	Description
812	**Built-In On-Off Switch (add $25)** A switch can be provided to turn the power to the controller on and off.
813	**Solid State Relay, Slow Cycling (add $90)** For driving contactors. A solid state relay rated at 10A. up to 240 V.A.C. in place of the standard plug-in relay. For single pole, single throw operation only (Form A). For all models (Main set point only).
844	**Solid State Relay, Fast Cycling (add $95)*** For driving resistive heater loads directly. A solid state relay rated at 10A. up to 240 V.A.C. in place of the standard plug-in relay. For single pole, single throw operation only(Form A). For all models except 50 and 56 (Main set point only). Zero crossover firing, except for first "on" cycle. Not compatible with 832 option.
814	**Three Mode PID Controller (add $65)** Adds reset (automatic offset correct) and rate modes. With over-shoot inhibit (exclusive feature automatically cuts out reset below and above proportional band). For Models 49, 57, 58 and 65. Not compatible with 832 option.
832	**Adjustable Proportioning Cycle Rate (add $45)** Inside adjustment can be set to change cycle rate over a range of 6 to 60 seconds at center of proportioning band. For Model 49 only. Not compatible with 844 option.
815	**Limit Control Power Interruption Circuit (add $35)** This circuit automatically resets the limit controller after a power interruption. Upon power interruption, and subsequent restoration, the control will return to the condition (normal or alarm) which existed prior to the interruption, if that condition still exists. For Model 50 only.
870	**Adjustable Wide On-Off Differential (add $55)** Same as option 89, except differential is adjustable up to 15% of range. For Model 50 set point only.
817	**Rear Terminal Enclosure (add $30)** Use this feature to surface mount the instrument or where terminals must be enclosed. Enclosure has knock-outs for 1/2" conduit connectors. Instrument depth is extended approx. 1 1/2 inches. Can be furnished separately.
818	**Recorder Output Terminals (add $40)** Providing output of 0-1 ma. at 0-1 V.D.C. This signal can be fed to most recorders for aux. recording. Use a standard temperature chart for your recorder brand in the same range as the controller. The recorder **does not** require ambient temperature compensation. Applies to all controllers and indicator.
837	**Thermistor Input (add $50)** For Omega's precision thermistors 44004 and 44007 as shown in the chart. Specify range desired.
89	**Fixed Wide On-Off Differential (add $45)** This feature is used for incinerators, furnaces or ovens where the control will turn off at the set point and will not turn on again until the controlled temperature drops to a predetermined temperature below the set point. Differentials of up to 20% of range can be furnished. Specify differential in percent of range and approx. operating set point. For Model 50 main set point only.
838	**Resistance Temp. Detector Input (add $45)** State range temperature vs. resistance curve.
	3 Wire Line Cord (add $6)

*Not field installable

THERMOCOUPLE RANGES

IRON–CONSTANTAN TYPE J			
RANGE	°/DIV.	RANGE	°/DIV
0- 300°F.	2	0-200°C.	2
0- 400°F.	5	0-300°C.	5
0- 600°F.	5	0-400°C.	5
0- 800°F.	5	0-600°C.	5
0-1000°F.	10	0-800°C.	5
0-1200°F.	10	−100 to +100°C.	2
0-1600°F.	10	−100 to +200°C.	2
−100 to +300°F.	5		
+200 to +600°F.*	5		
+250 to +550°F.*	2		
CHROMEL–ALUMEL TYPE K			
RANGE	°/DIV.	RANGE	°/DIV
0- 600°F.	5	0- 600°C.	5
0-1000°F.	10	0-1000°C.	10
0-1200°F.	10	0-1200°C.	10
0-2000°F.	20	0-1350°C.	10
0-2300°F.	20		
0-2500°F.	20	+200 to +600°C.*	5
+800 to +1600°F.*	5		

*For suppressed range, add $15.00 to price of each instrument.

CHROMEL–CONSTANTAN TYPE E			
RANGE	°/DIV.	RANGE	°/DIV.
0- 600°F.	10	0-400°C.	5
0-1830°F.	10	−100 to +100°C.	5
−50 to 250°F.	5	−250 to 0°C.	5
−150 to +150°F.	2		
−300 to +100°F.	5		
COPPER–CONSTANTAN TYPE T			
0-400°F.	5	0-200°C.	2
−100 to +300°F.	5	0-400°C.	5
−300 to +480°F.	5	−100 to +200°C.	2
−350 to +200°F.	5	−215 to +125°C.	5
PLAT. 13% RHODIUM–PLAT. TYPE R			
0-3000°F.	20	0-1600°C.	10
0-2500°F.	20		
PLAT. 10% RHODIUM–PLAT. TYPE S			
0-3000°F.	20	0-1600°C.	10
TUNGSTEN 5% RHENIUM–TUNGSTEN 26% RHENIUM			
0-3500°F.	20	0-2200°C.	20

Thermistor Ranges for 44007	
5000 ohms @ 25°C (for use with Option 837 only)	
Range	**°/Div.**
+ 65° to +215°F	1°F
+115° to +215°F	1°F

Thermistor Ranges for 44004	
2252 ohms @ 25°C (for use with Option 837 only)	
Range	**°/Div.**
−90° to + 20°F	1°F
+70° to +220°F	1°F
+10° to + 40°C	.2°C

RTD Ranges (Option 838)	
100 ohms at 0°C (Plat.) α = .00385	
Range	**°/Div.**
−120 to +350°F/ −85 to +175°C	5/5
0 to 200°C	2
0 to 400°C	5
0 to 600°C	5

TO ORDER: (1) Specify model (either 49 or 50). (2) Specify calibration (J, T, K, E, R or S). (3) Specify range and scale (either °C or °F). (4) List all options. EXAMPLE: Model 49J-0/400°C with Option 818. This signifies an iron-constantan, proportioning controller, with a 0°C to 400°C range and recorder output terminal option. The recorder plus option total $260

Additional Options and Ranges Available

Additional Options Available
(Consult Factory For Delivery)

874	Hermetically sealed relay, 10A @ 120 VAC, 5A @ 240 VAC main set point only. For Group D Class I Division II hazardous locations. For models 49 and 50.	$100
8102	Factory Mutual approved limit control. Set point is screwdriver adjusted behind plug bottom. F.M. file No. 24194. Other listed options for use with this option are: 89, 812, 816, 817, 837, 838, 842, and 859. For Model 50 only. For other models see Option 8132.	$45
8132	Set point is screwdriver adjusted behind plug bottom. This option is available on all models. For F.M. approved Model 50, see Option 8102.	$45
8156	Splash and dust resistant cover. Snaps over bezel of any Controller, or Indicator. Has internal bezel sealing gasket. Molded from high impact, high temperature, transparent polysulfone that is F.D.A. acceptable for the Food and Dairy Industries. Used on all models.	$25

Additional Ranges Available
(Consult Factory for Price and Delivery)

Thermocouple

Iron-Constantan (Type J)

Range	°Div
0 to 300°F/0 to 150°C	2&2
0 to 600°F/0 to 315°C	5&2
0 to 800°F/0 to 400°C	5&5
0 to 1200°F/0 to 600°C	10&5
−150 to +200°F	2
−320 to +200°F	5

Copper-Constantan (Type T)

Range	°Div
0 to 600°F	5
0 to 750°F	5
−100 to +400°F	5
−100 to +700°F	5
−120 to + 350°F	5
−120 to +350°F/−85 to +175°C	5&5
−125 to +500°F	5
−350 to +400°F	5
−350 to +500°F	5
−100 to +150°C	2
−100 to +250°C	5
−100 to +300°C	5
−100 to +350°C	5

Chromel-Alumel (Type K)

Range	°Div
0 to 800°F	10
0 to 1600°F	10
0 to 2000°F/0 to 1100°C	20&20
0 to 2500°F/0 to 1370°C	20&20
+1000 to +2400°F*	10

(*Add $15.00 to price for suppressed range.)

Chromel-Constantan (Type E)

Range	°Div
0 to 300°F	2
−100 to +300°F	5
−200 to +800°F	10
−320 to +100°F	5
−320 to +100°F/−194 to +36°C	5&2
0 to 225°C	2
0 to 300°C	2
0 to 800°C	10

Plat. 13% Rhodium-Plat. 10% (Type R)

Range	°Div
0 to 2500°F	20
0 to 3000°F	20
+1000 to +2500°F*	10
0 to 1700°C	10

Plat. 6% Rhodium-Plat. 30% (Type B)

Range	°Div
0 to 3200°F	20
0 to 3300°F/0 to 1800°C	20&20

Plat. 10% Rhodium-Plat. (Type S)

Range	°Div.
+1000 to +2500°F*	10

Tungsten 3% Rhenium-Tungsten 25% Rhenium

Range	°Div
0 to 2000°C	20

Tungsten 5% Rhenium-Tungsten 26% Rhenium

Range	°Div
0 to 3500°F	20
0 to 2200°C	20

Thermistors, Option 837

Range	Type	°Div
+ 40 to +180°F	5K @ 25°C	1
+ 50 to +150°F/ + 10 to + 65°C	5K @ 25°C	1&5
+ 50 to +250°F	5K @ 25°C	2
+ 75 to +125°F	5K @ 25°C	1
+120 to +160°F	5K @ 25°C	5
+150 to +200°F	5K @ 25°C	1
+150 to +250°F	5K @ 25°C	1
+200 to +250°F	5K @ 25°C	5
+225 to +260°F	5K @ 25°C	2
+ 30 to + 50°C	5K @ 25°C	2

Resistance Thermometers, Option 838

Range	Type =.00385	°Div
0 to 300°F	100 ohms @ 0°C PLT	2
0 to 600°F	100 ohms @ 0°C PLT	5
−120 to 350°F	100 ohms @ 0°C PLT	5
+200 to +400°F	100 ohms @ 0°C PLT	2
+200 to +400°C	100 ohms @ 0°C PLT	2
− 25 to 75°C	100 ohms @ 0°C PLT	1
−100 to +250°C	100 ohms @ 0°C PLT	5
− 50 to +150°F	100 ohms @ 0°C PLT	5

(*Add $15.00 to price for suppressed range.)

Digital Set Point, Digital Indicating Temperature Controls and Indicators

- One Inch High, Back Lighted, Liquid Crystal Display
- Very High Accuracy
- Switch Selectable °F or °C
- Thermocouple, Thermistor or RTD Input
- Heating and Cooling Lights
- Selectable Set Point Ranges
- Press-To-Set Knob
- Upscale or Downscale Thermocouple Break Protection is Field Selectable
- Full Plug-In Construction
- Plug-In Circuit Cards
- Plug-In Transformer
- Thermostatic Cutout Protection for Power Transformer
- Spring Return Door for Inside Panel Adjustments
- Barrier Terminal Connections
- 120/208/240 V.A.C., 50/60 Hz. Voltage Inpu
- Fully Gasketed
- Only 4" H. x 4¼" W. x 7⅛" Deep behind Panel. Fits International 3⅝" x 3⅝" Panel Cutout.
- Made in U.S.A.

Features

DISPLAY is a high temperature liquid crystal type with one inch numbers. It is back lighted for viewing in any background lighting conditions. All numbers and characters appear white on a black background. Leading zero blanking is incorporated so that zeros do not appear in front of number.

°F or °C SWITCH gives the user the choice of indicating in degrees fahrenheit or degrees celsius.

SET POINT(S) and process input temperatures appear on the same display.

SCAN MODE allows set points to be displayed automatically at selectable time intervals. At all other times, the process temperature is displayed. The set points may be viewed at any time by actuation of the set point switch.

PRESS-TO-SET main set point knob sets main set point.

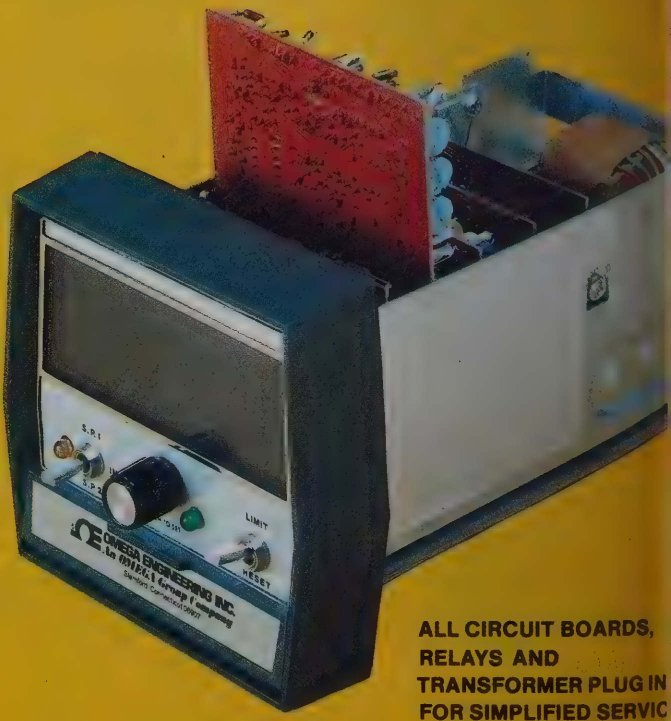
LIGHTS are all extra bright LED units.

HINGE DOWN DOOR, with spring return, hides adjustments.

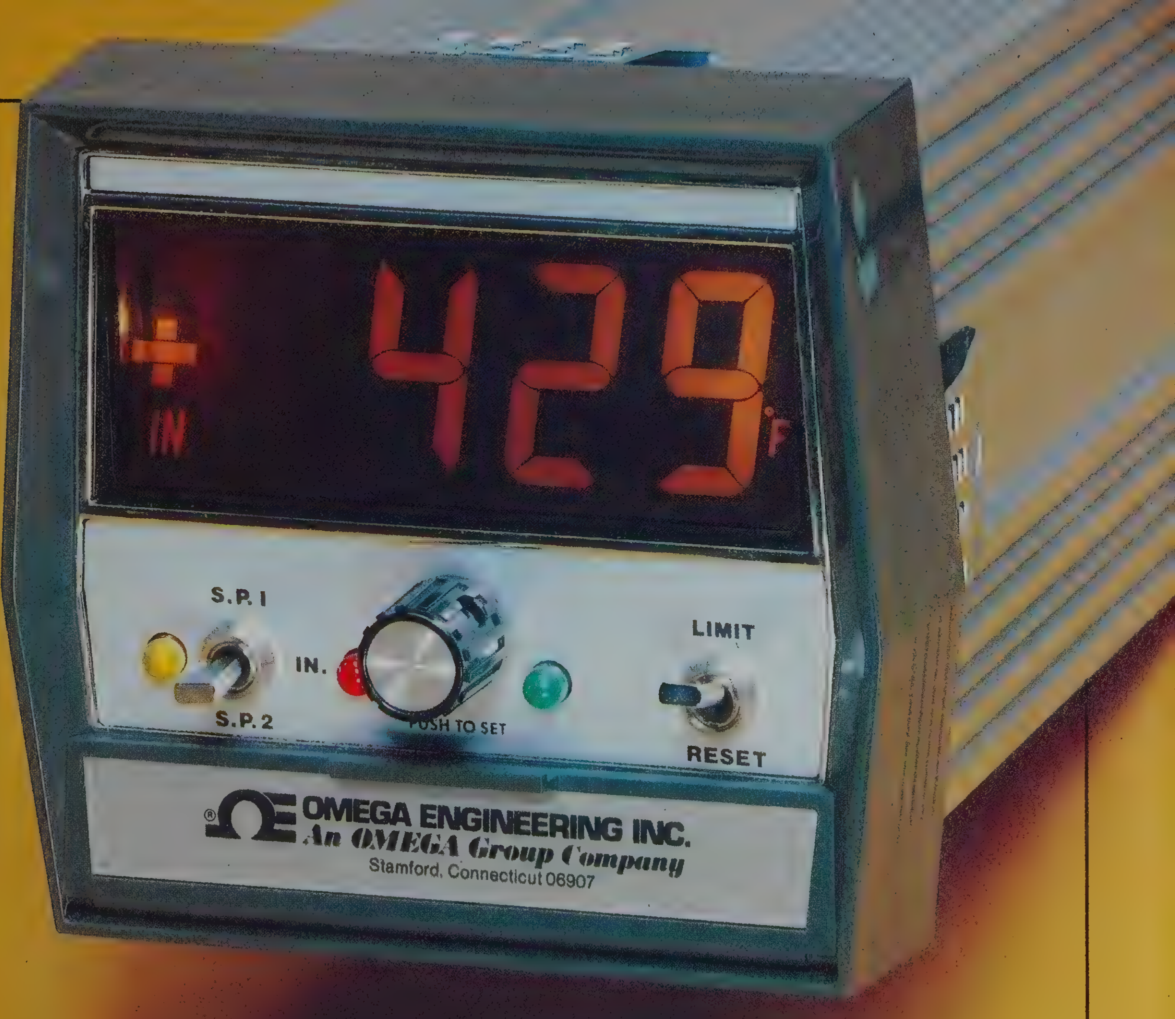
FULL PLUG-IN allows removal of the entire control from its housing without removing wiring.

PLUG-IN COMPONENTS facilitate servicing and range changing. All internal circuit boads, relays, transformer and other components plug in.

RELAYS are rated at 10A. @ 120 V.A.C. or 5A. @ 240 V.A.C. for both main and second set points. Both relays are fused.



ALL CIRCUIT BOARDS, RELAYS AND TRANSFORMER PLUG IN FOR SIMPLIFIED SERVIC OR CONVERSION.



INPUT VOLTAGE can be 120, 208, or 240 V.A.C., 50/60 Hz. Selection is made at time of wiring.

TRANSFORMER is thermostatically protected from overload.

RANGE LIMITING permits selection of set point ranges within the indication range of the instrument without affecting the indication range.

WIRING is extremely convenient. Large screw terminals are provided on the rear of the housing. Barriers between terminals prevent accidental shorting.

Operation

The main set point (set point #1) is set by actuating the set point #1 switch and turning the press-to-set knob until the desired setting appears on the display. "S.P.I." also appears on the display while setting.

The second set point (set point #2) is set by actuating the set point #2 switch and turning the set point #2 adjusting potentiometer, located behind the hinge-down door, until the desired setting appears on the display. "S.P. 2" appears on the display while setting. Settings may be checked at any time by actuating the set point switch to either set point #1 or set point #2.

When the set point switch is released, the process temperature appears on the display and "IN" (for input) also appears on the display.

Two modes of display operation may be selected:

1) *Scanning* — In this mode the process temperature is displayed for a pre-selected time period of approx. 10, 15, 20, 30 or 40 seconds and S.P. #1 and S.P. #2 will automatically appear on the display after this time period for 5 seconds each. The display will then return to reading the process temperature. This scan will automatically and continuously repeat itself.

2) *Process display only* — In this mode the display will continuously indicate the process temperature. The set point settings may be viewed at any time by actuating the set point switch to "S.P.1" or "S.P.2".

Over-range indication is provided on the display by the appearance of an arrow, " ← ", with the numbers on the display going blank. If the display is indicating process temperature and this arrow appears, this indicates either that the temperature is higher than the range of the instrument or that the thermocouple break protection is activated.

If the arrow appears while setting the set point, this indicates that the setting being made is beyond the set point range of the control.

While the display will indicate the process temperature over the entire range of the controller, the set point range may be limited by an internal adjustment, thus providing range selection. See "Ranges".

An important feature in the instrument is the switch selectable °F. or °C. A slide switch, which may be actuated with a small screwdriver, or pencil, selects whether the instrument display will read in either °F. or °C. At the same time the display indicates which has been selected.

Control Types

ON-OFF is a relay output. When on the main set point, it can be used to cycle the heat on and off within a narrow differential. Time proportioning or proportional output is recommended for closer control. On-off should only be used where tight control is not required or where only a signal contact is needed.

When on-off control is on the second set point, it may be used to open or close a circuit either above or below the main set point. These can include either a high or low limit signal or shutdown or as an interlock circuit to prevent operation of equipment until the temperature has reached a specific temperature. It may also activate a cooling circuit.

LIMIT is also a relay output. The **OMEGA** circuit in limit controls allows selection of either high limit or low limit. In addition, either manual limit reset or automatic limit reset may be selected. With manual limit reset, the limit relay will not transfer back to normal, after a limit temperature has been reached, until the temperature has returned to normal and the limit reset switch has been activated.

With automatic limit reset the limit relay will transfer back to normal as soon as the temperature returns to normal.

All models with limit main or second set points also have provisions for remote limit reset.

Time proportioning automatically proportions the relay on-off time in accordance with the demand of the process to closely hold the set point temperature.

All time proportioning and proportional controls feature 3-mode control as standard. This allows even the most unstable heating systems to be controlled within the closest limits.

The *Proportional Band* (gain) is fully adjustable. In a proportional controller, the output or control signal is proportional to the difference between the set point value and the actual process temperature, when the actual temperature is within the proportional band. This band is a region which extends above and below the set point. The bottom edge of the band represents 100% output value, while the top represents 0% output value. By bandwidth adjustment the number of degrees, over which this proportional output occurs, can be changed. If the bandwidth is narrowed, the change occurs more rapidly (increased gain). If the bandwidth is widened, the change occurs more slowly (decreased gain).

AUTOMATIC RESET (Integral) plus a Windup Eliminate Circuit corrects offset from the control point. In all proportional controllers the controlled temperature can stabilize at any temperature within the proportional band as described above. If this temperature should be either above or below the temperature which was set on the controller, this is called "offset".

If, for example, the process requires 90% input power to maintain the set temperature, the temperature is going to settle out in the lower portion of the proportional band. This is below the actual set point. Since the set point is in the center of the band (50% input power), the controller automatic reset circuit causes the band to move upscale so that the 90% position of the band is at the set point instead of below it. If the process requires lower power to maintain temperature (like 20%), the band would move downscale so that the 20% position of the band is at the set point.

It can be seen from the above that the reset function is not required until the actual process temperature enters the proportional band. If this circuit functioned without restraint, the band would move much too far upscale during initial heat-up (when the temperature is far below the set point) or too far downscale upon lowering the set point from a higher temperature. This is called "windup" and it would cause serious over or undershooting of the set point.

Most manufacturers provide windup inhibiting circuits, which limit the movement of the band. **OMEGA'S** exclusive patented Windup Eliminate Circuit removes the reset feature entirely if the process temperature is either below or above the proportional band. This eliminates windup entirely.

The reset circuit can actually cause the temperature to cycle around the set point if it is set too fast for the process being controlled. **OMEGA** controllers provide a fully adjustable reset circuit, so that the proper reset time can be selected.

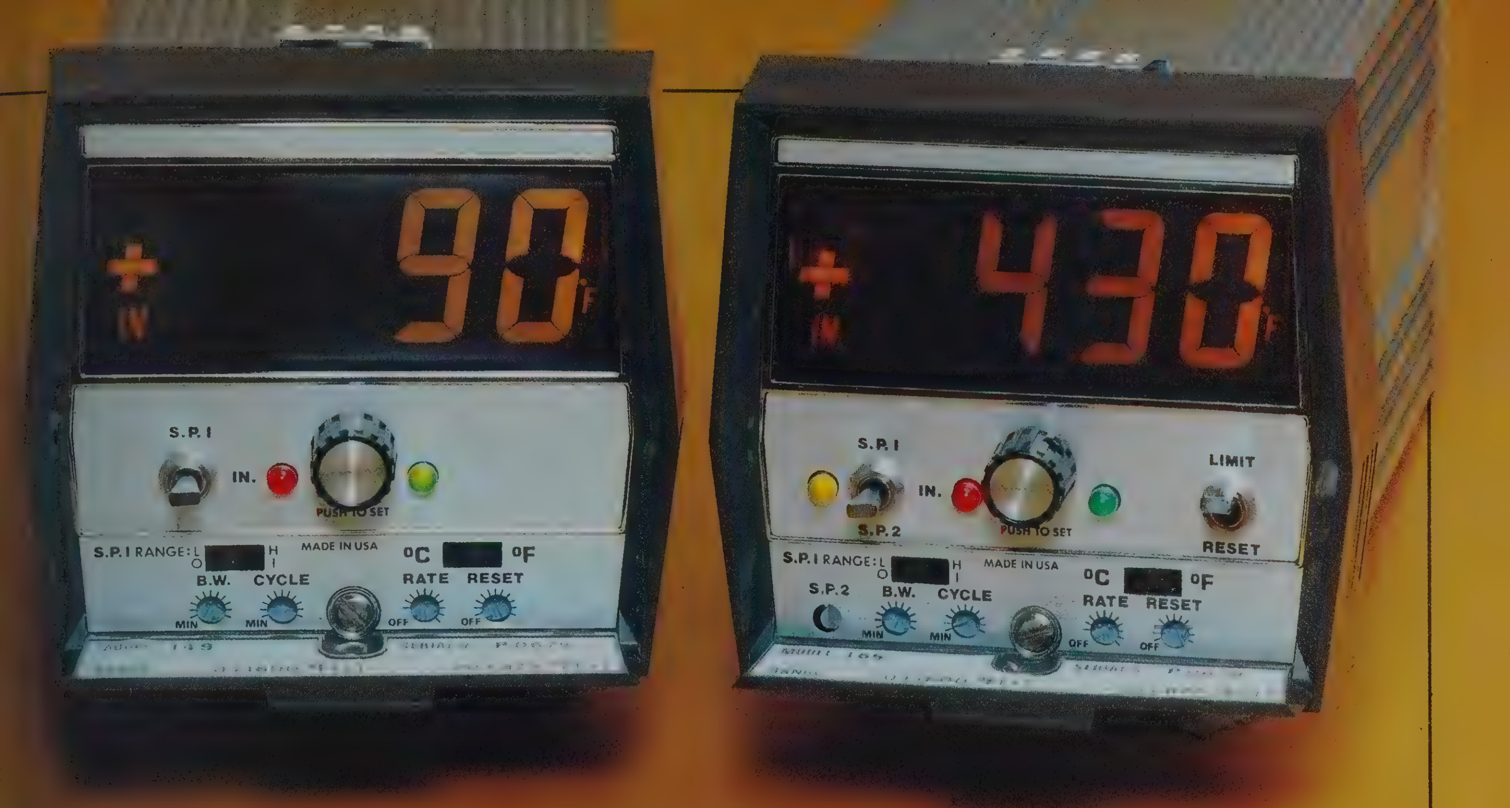
AUTOMATIC RATE (Derivative) anticipates sudden line, load or process upsets and applies immediate correction. On slow reacting systems where there is a long time constant between change of process temperature and the sensing of that change, the automatic rate circuit causes the control to make larger corrective output change than with proportional action only. This corrective rate of change is fully adjustable.

The **OMEGA** rate circuit is particularly useful in very fast heating systems that have low mass with high energy input. This condition will cause overshooting of the set point if the output charge did not occur until the lower band edge was reached. The rate circuit recognizes that the rate of approach to the set point would cause an overshoot so it starts to cut back output *before* the band edge is reached. This circuit is automatic, so that the rate of approach determines how much the circuit will cut back the output.

The **OMEGA** rate circuit is independent of the reset circuit so set point changes, once the temperature has stabilized at a gi set point, do not result in unstable operation of the controller.

CYCLE RATE in **OMEGA** time proportioning controllers is not fixed as compared to other manufacturers' systems where the total of the on time plus the off time always adds up to the sam number regardless of the temperature position within the band. Cycle rate changes must be made within the band. Cycle rate changes must be made manually to match the process. In the **OMEGA** time proportioning controls, the cycle rate adjustment that is provided is used only to select the cycle rate at the center of the band (50% on, 50% off). If, for example, 6 seconds on and 6 seconds off (12 seconds) is selected, at the band edge the total on and off time can reach 35 to 60 seconds, like 4 seconds on and 50 seconds off. This cycle rate adjustment is fully automatic and is dependent upon the demand of the heating system.

As stated above, the cycle rate adjustment provided is used only to select the cycle rate at the center of the band. This allows the user to slow up the cycle time to increase contactor life or where a time proportioning control is used on a refrigeration compressor which cannot be actuated on and off at a normal proportioning cycle rate.



HINGE DOWN DOOR OPENED TO REVEAL ADJUSTMENTS.

Dual Set Point Models

Dual set point models, having an on-off second set point, feature completely independent set point adjustments. The main set point and the second set point may each be set anywhere within the range of the controller.

With a time proportioning or pulse cooling second set point, the set points are adjustable with relation to each other from full overlap to a deadband between them. If the main set point is moved the second follows along and holds the same relationship. These models should be used for heating-cooling applications.

The Model 158 is particularly useful on air-cooled plastics extruders. The Model 159 was specifically designed for water cooled extruders and greatly reduces the need for complex cooling water metering.

Ranges

Although the controller will indicate over the entire range of the instrument, the main set point range may be field selected for approximately 25%, 50%, 75% and 100% of span (4 break points). For example, a controller having a range of 0 to 1600°F type J can have a set point range of 0-400°F, 0-800°F, 0-1200°F or 0-1600°F. If one of the lower ranges is selected, resolution is increased.

In addition, the "LO-HI" switch on the front of the controller splits in half the set point range that was selected. Therefore, if 0-800°F. was selected, the "LO" setting of the switch makes the set point range 0° to approx. 420°F and the "HI" setting makes the range approx. 380° to 800°F.

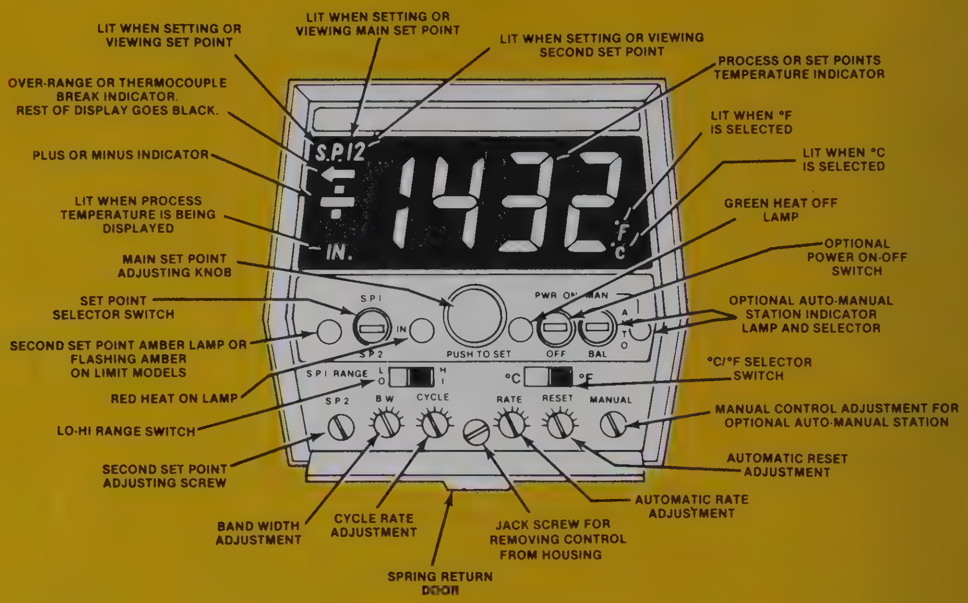
No matter what range is selected for the main set point, the second set point on two set point controllers (except proportioning or pulse cooling second set points) is still adjustable over the entire range of the control.

When smaller span ranges are ordered, range selection may be fewer than the 4 break points offered on the wide range units.

Standard Ranges

RANGE	TYPE	RESOLUTION
−350 to +999°F. (−212 to +537°C.)	J	1°
−4 to +1607°F. (−20 to +875°C.)	J	1°
−364 to +1022°F. (−220 to +550°C.)	K	1°
−184 to +2500°F. (−120 to +1370°C.)	K	1°
−346 to +320°F. (−210 to +160°C.)	T	1°
−274 to +752°F. (−170 to +400°C.)	T	1°
−310 to +1832°F. (−190 to +1000°C.)	E	1°
−4 to +3200°F. (−20 to +1760°C.)	R	1°
−4 to +3200°F. (−20 to +1760°C.)	S	1°
+122 to +3308°F. (+50 to +1820°C.)	B	1°
+5 to +185°F. (−15 to +85°C.)	Thermistor, 5K OHMS @ 25°C Cal. #101, Option 737	0.1°
−328 to +1607°F. (−200 to +875°C.)	RTD, Plat. 100 OHMS @ 0°C. DIN (European) Curve .00385 OHMS/OHM/°C. Cal. #106, Option 738	1°
−175 to +635°F (−115 to +335°C)	RTD, Plat. 100 OHMS @ 0°C. DIN (European) Curve .00385 OHMS/OHM/°C Cal #106, Option 738	0.1°

CONTROLLER PANEL ARRANGEMENT


LIT WHEN SETTING OR VIEWING SET POINT
LIT WHEN SETTING OR VIEWING MAIN SET POINT
LIT WHEN SETTING OR VIEWING SECOND SET POINT
PROCESS OR SET POINTS TEMPERATURE INDICATOR
OVER-RANGE OR THERMOCOUPLE BREAK INDICATOR. REST OF DISPLAY GOES BLACK.
LIT WHEN °F IS SELECTED
PLUS OR MINUS INDICATOR
LIT WHEN °C IS SELECTED
LIT WHEN PROCESS TEMPERATURE IS BEING DISPLAYED
GREEN HEAT OFF LAMP
MAIN SET POINT ADJUSTING KNOB
OPTIONAL POWER ON-OFF SWITCH
SET POINT SELECTOR SWITCH
OPTIONAL AUTO-MANUAL STATION INDICATOR LAMP AND SELECTOR
SECOND SET POINT AMBER LAMP OR FLASHING AMBER ON LIMIT MODELS
°C/°F SELECTOR SWITCH
RED HEAT ON LAMP
LO-HI RANGE SWITCH
MANUAL CONTROL ADJUSTMENT FOR OPTIONAL AUTO-MANUAL STATION
SECOND SET POINT ADJUSTING SCREW
AUTOMATIC RESET ADJUSTMENT
AUTOMATIC RATE ADJUSTMENT
BAND WIDTH ADJUSTMENT
CYCLE RATE ADJUSTMENT
JACK SCREW FOR REMOVING CONTROL FROM HOUSING
SPRING RETURN DOOR
S.P.12
1432
IN.
F
C
SPI
IN
SP2
PUSH TO SET
PWR ON
MAN
OFF
BAL
A
T
O
SPI RANGE
L
O
H
I
°C
°F
SP2
BW
CYCLE
RATE
RESET
MANUAL

Specifications

INPUT: Thermocouple, Thermistor or RTD.

INPUT IMPEDANCE: Greater than 500,000 ohms.

COMMON MODE REJECTION: Greater than 120 DB @ 240 V.A.C. (60 Hz.).

ACCURACY: ±0.25% of span or ±1° whichever is greater (± least significant digit).

REPEATABILITY: ±0.1% of span.

RESOLUTION: 1° or 0.1° dependent upon range.

PROPORTIONAL BAND: Adjustable, 0.5 to 30% of span on time proportioning and proportional models.

AUTOMATIC RESET (INTEGRAL): Adjustable, off to 15 minutes (off to 0.06 repeats per minute). On time proportioning and proportional models.

AUTOMATIC RATE (DERIVATIVE): Adjustable, off to 3 minutes.

CYCLE RATE: Adjustable, 5 to 50 seconds, in center of band. On time proportioning models.

ON-OFF DIFFERENTIAL: On-off models only. 0.3 to 0.7% of span.

SETABILITY: ±1 least significant digit.

MAXIMUM THERMOCOUPLE RESISTANCE: 300 ohms with rated accuracy.

SUPPLY VOLTAGE: 120/208/240 V.A.C. 50/60 Hz., by terminal selection.

LINE VOLTAGE STABILITY: ±0.2% of span maximum, within 85 to 110% of rated line.

CONTROL RELAYS: Relay output models only. Plug-in, 10A. (120 V.A.C.), 5A. (240 V.A.C.) non-inductive. Single pole, double throw contacts. Ratings apply to both main and second set point relays.

TRANSFORMER: Plug-in, thermostatically protected.

FUSES: Common contacts of main and second set point relays are internally fused for 10A. with 3AB250 V. fuses. Solid state 10A. output models are supplied with very fast blow fuse, type KAX 10 (10A.) and externally mounted fuse block. This same fusing is supplied with solid state output option 713. Solid state 30A. output models are supplied with a power unit fused with a type KAX 30 (30A.) fuse.

AMBIENT TEMPERATURE RANGE: 2 to 60°C. (35 to 140°F.) maximum.

TEMPERATURE STABILITY: 7 uV./°C. (4 uV/°F.) maximum.

HUMIDITY CONDITIONS: 0 to 70% R.H. normal operation; 0 to 90% R.H. extreme operating conditions.

THERMOCOUPLE BREAK PROTECTION: Selectable up-scale or down-scale standard. Display indicates over-range arrow upon thermocouple break.

OPEN RTD PROTECTION: Standard for RTD ranges.

SHORTED RTD PROTECTION: Standard for RTD ranges.

OPEN THERMISTOR PROTECTION: Standard for thermistor ranges.

CONTROLLER WEIGHT: Approx. 4 to 5 lbs. depending upon model.

TO ORDER: SPECIFY MODEL, RANGE AND OPTIONS DESIRED.

	CONTROL TYPE		
MODEL	MAIN SET POINT	SECOND SET POINT	PRICE
148	ON-OFF	NONE	$515
149	TIME PROPORTIONING	NONE	585
150	LIMIT, HIGH OR LOW	NONE	535
156	ON-OFF	ON-OFF	565
157	TIME PROPORTIONING	ON-OFF	635
158	TIME PROPORTIONING	TIME PROPORTIONING	640
159	TIME PROPORTIONING	PULSE-COOLING	670
164	ON-OFF	LIMIT, HIGH OR LOW	580
165	TIME PROPORTIONING	LIMIT, HIGH OR LOW	650
166	LIMIT, HIGH OR LOW	LIMIT, HIGH OR LOW	600

ptions

ption #	Descriptions
712	**BUILT-IN ON-OFF SWITCH (Add $25)** A switch can be provided on the front panel to turn power to the controller on and off.
713	**SOLID STATE OUTPUT (Add $65)** This circuit replaces the relay in on-off, time proportioning or limit controllers. The solid state output is rated at 10A. up to 240 V.A.C. For single pole, single throw operation only (form A.). A separate fuse block and very fast blow fuse (type KAX-10) are supplied with this option.
770	**ADJUSTABLE WIDE ON-OFF DIFFERENTIAL (Add $45)** Control will turn off at the set point and will not turn on again until the controlled temperature drops to a predetermined temperature below the set point. Differential is adjustable up to 15% of span. For on-off models, on main set point only.
717	**REAR TERMINAL ENCLOSURE (Add $25)** Use this option to surface mount the instrument or where terminals must be enclosed. Enclosure has knock-outs for 1/2" conduit connectors. Instrument depth is extended approximately 1 1/2 inches. Can be furnished separately.
718	**RECORDER OUTPUT TERMINALS (Add $30)** Providing linearized output of 0-5 V.D.C. into 500 ohms or greater resistance. This signal can be fed to most recorders for aux. recording. Since the output signal is linearized, a linear chart may be used. This signal may also be used into a digital voltmeter for aux. monitoring. The recorder *should not* have ambient temperature compensation. This option applies to all models.
738	**RTD, RESISTANCE TEMPERATURE DETECTOR INPUT (Add $40)** Specify range from range list. RTD lead wire break and shorted RTD protection is included.
737	**THERMISTOR INPUT (Add $40)** Specify range from range list. Open thermistor protection is included.
156	**SPLASH RESISTANT COVER (Add $25)** Cover snaps onto and seals the front of the controller. Made from transparent, F.D.A. acceptable, polysulfone.
8162	**TAMPER RESISTANT COVER (Add $25)** Same as the splash resistant cover except that it is provided with screws (top and bottom) that lock into two blind holes in the instrument bezel. The instrument must be supplied with these holes. See option 7166 below.
7166	**BLIND HOLES IN INSTRUMENT BEZEL (Add $10)** Holes are supplied in the instrument bezel to allow use of tamper resistant cover above.
748	**DIFFERENTIAL SECOND SET POINT ADJUSTMENT (Add $30)** Dual set point models with on-off or limit second set points adjustable within a range of −30% to +30% of span relative to the main set point. If the main set point is moved, the second set point will follow and hold the same relationship as originally set.
7501	**AUTO-MANUAL STATION (Add $75)** Allows manual control of process with bumpless transfer from automatic to manual.

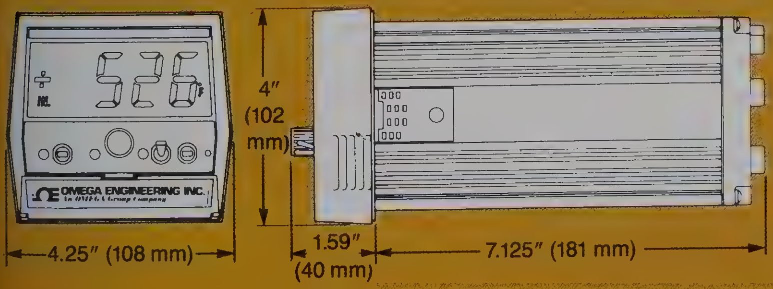
+
IN
97
°F
S.P. I
IN.
PUSH TO SET
OMEGA ENGINEERING INC.
An OMEGA Group Company
Stamford, Connecticut 06907

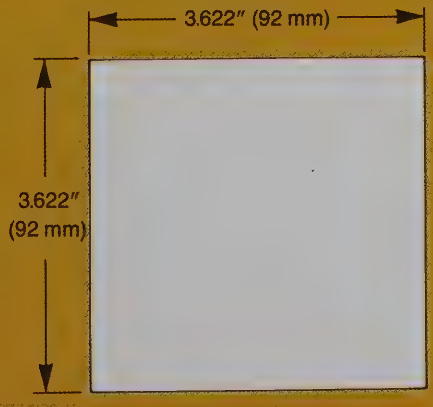
Relay Output Controls

All relay output models have plug-in relays rated at 10A. @ 120 V.A.C. or 5A. @ 240 V.A.C. Fusing is provided internally in the common leg of the single pole, double throw contacts.

imensions

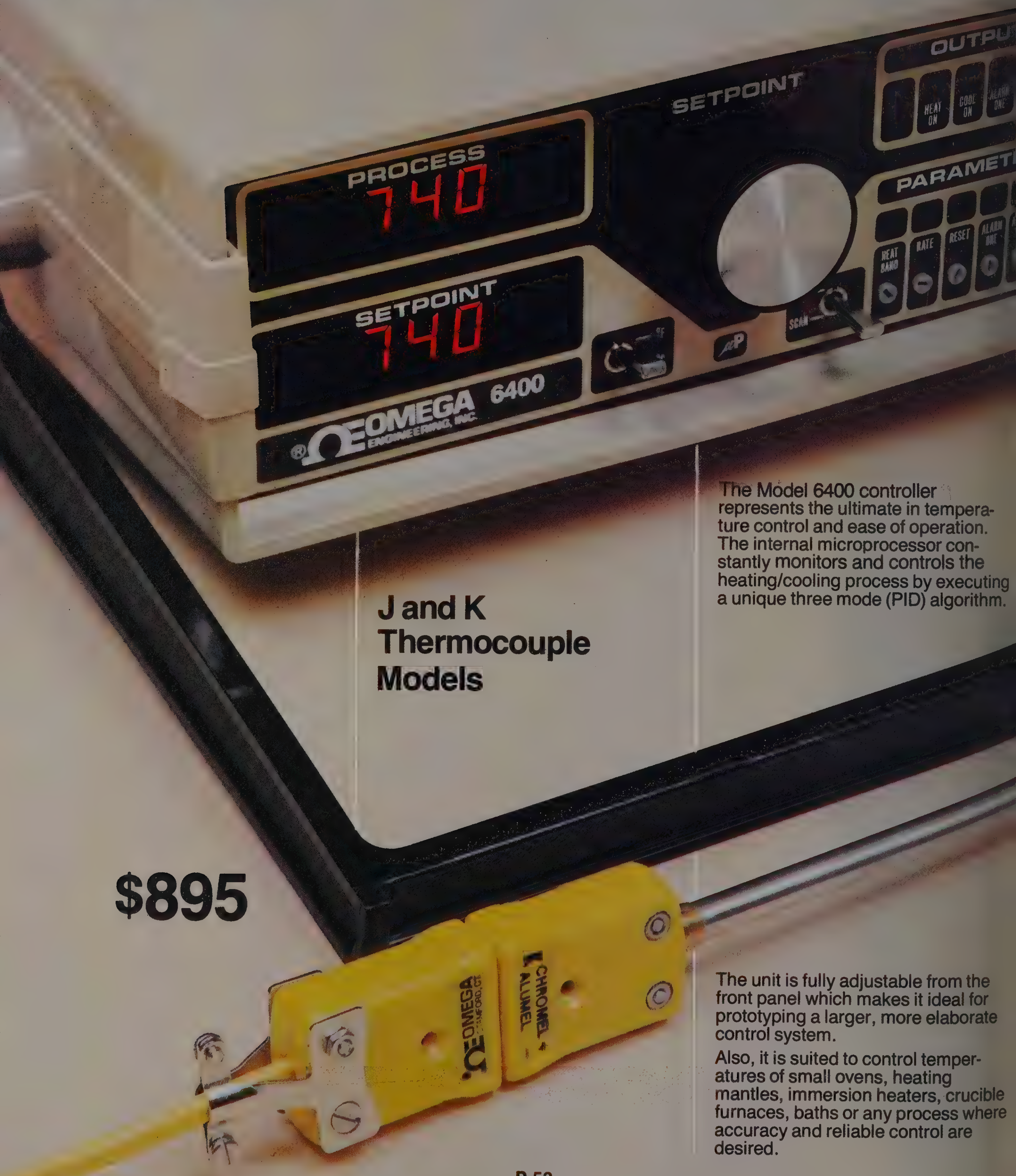
LL CONTROLLERS AND INDICATORS





PANEL CUT-OUT

Microprocessor Controller
Precision Heating and Cooling
Model 6400


PROCESS
740
SETPOINT
740
OMEGA ENGINEERING, INC.
6400
SETPOINT
OUTPU
HEAT ON
COOL ON
ALARM ONE
PARAMETI
HEAT BAND
RATE
RESET
ALARM ONE
SCAN
°F
μP
OMEGA STAMFORD, CT
CHROMEL +
ALUMEL -

J and K Thermocouple Models

$895

The Model 6400 controller represents the ultimate in temperature control and ease of operation. The internal microprocessor constantly monitors and controls the heating/cooling process by executing a unique three mode (PID) algorithm.

The unit is fully adjustable from the front panel which makes it ideal for prototyping a larger, more elaborate control system.

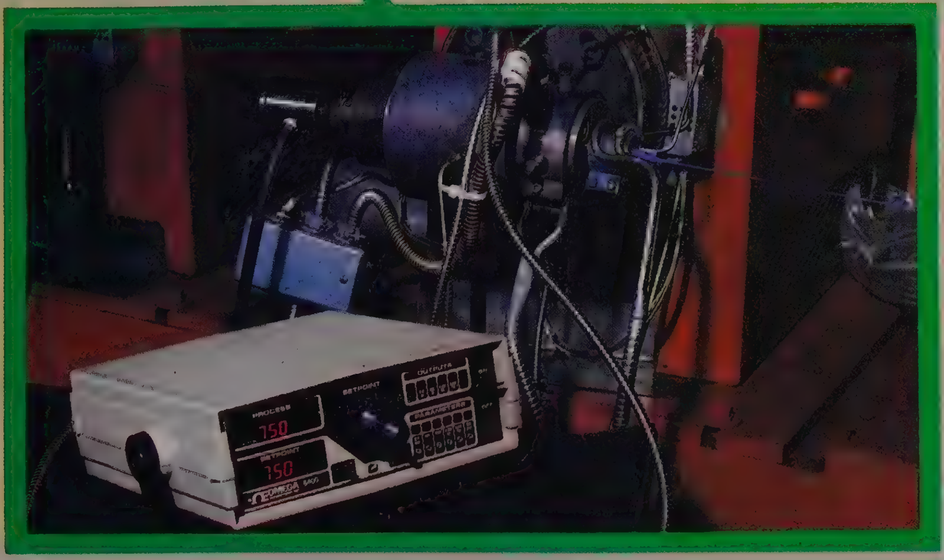
Also, it is suited to control temperatures of small ovens, heating mantles, immersion heaters, crucible furnaces, baths or any process where accuracy and reliable control are desired.

- Fully Adjustable PID Control Action
- Advanced Microprocessor Technology
- Unique Three Mode Algorithm
- Mathematically Derived Thermocouple Linearization
- Continuous Display of Process Temperature in °C or °F
- Set Point or Other Parameters Viewed on Second Display
- Heating/Cooling Control with Two Alarms
- Recorder Output

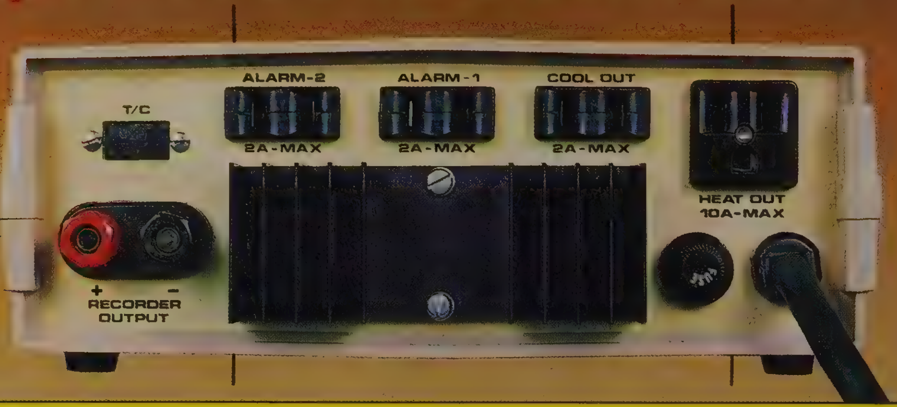
Industry

Laboratory

Production


PROCESS
750
SETPOINT
750
OUTPUTS
PARAMETERS
OMEGA

Microprocessor Controller



Specifications

INPUTS

Line Voltage:	120 V ac −15, +10%, 50-60 Hz
Sensor:	Type J Thermocouple (Iron Constantan), 0 to 1400°F and −17.8 to 760°C. Type K Thermocouple (Chromel-Alumel), 0 to 2000°F and −17.8 to 1093°C.
Power Consumption:	Less than 6 VA (instrument only)
Accuracy:	±0.2% of span
Temperature Stability:	5μ V/°C maximum, 3μ V/°C typical
Cold End Tracking:	0.05°C/°C ambient
Operating Ambient*:	0 to 55°C
Maximum T/C Lead Resistance*:	100Ω
Series Mode Noise Rejection:	80 dB
Common Mode Noise Rejection:	140 dB
T/C Break Protection:	Upscale standard
Dual Display:	Process temperature displayed continuously. Set point or other parameters can be updated on lower display
°F/°C:	Front panel selectable. Automatically converts process set point to °F or °C
Alarm 1 & 2:	Adjustable over full range of control, LED displays alarm condition, 2 amp Triac output per alarm
Heat/Cool:	Heating 10 amp Triac with receptacle, 2 amp Triac for cooling

ADJUSTMENTS

Cycle Rate:	Cycle rate for heating & cooling independently switch selectable for 1, 2, 10, 40 seconds (internal)
Rate (Derivative Action):	Front panel adjustable over the range of 0 to 100 seconds
Reset (Integral Action):	Front panel adjustable over the range of 0 to 400 seconds
Proportional Band (Gain) Heat:	Front panel adjustable over the range of 1 to 200% of span
Proportional Band (Gain) Cool:	Front panel adjustable over the range of 1 to 200% of span.
Anti Reset Windup:	Standard
Filtered LED Display:	4 digits for process, 4 digits for parameters
T/C Linearization:	Continuously calculated and updated using ROM based algorithm

OUTPUTS

Heat:	Grounded 3 wire receptacle provides 10 amps at 120 V ac to control most laboratory processes or immersion heaters directly
Cool:	AC receptacle for direct drive of small cooling fans or refrigeration valves up to 2 amps continuous
Alarm 1 & Alarm 2:	AC receptacle provides direct drive to warning lights, buzzers or relays to alert operators or shut down thermal system in the even of runaway conditions. Control up to 2 amps at 120 V ac directly. Alarms may be configured for high or low
Recorder Output:	1 mV/°F and 1.8 mV/°C
Dimensions:	H: 3 1/4'' (82.5 mm) x W: 9 3/4'' (247.7 mm) x D: 10 1/4'' (260.4 mm)
Weight:	4 lbs. 10 oz. (1.8 kg)

How To Order

Specify: Model 6400 - [ ]

J thermocouple
0° to 1400°F
(−17.8°C to 760°C)

K thermocouple
0° to 2000°F
(−17.8°C to 1093°C)

$895

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*For rated accuracy.

Temperature Controllers

IN PORTABLE BENCH TOP CASES!

- Fully Wired
- Easy-to-Use

1999 °F
OMEGA
READ
NEW!

Model 4002 Shown

$460

Dual Setpoints

Portable Temperature Controller in a case. Let OMEGA put one of our precision temperature controllers in a convenient bench stand case for your control and alarm applications.

The Controller in a case is fully wired and ready to use with receptacles for sensor input and power output. No costly installation or wiring is required.

Standard features include an illuminated on/off power switch, heavy duty 3-wire power cord, plus power line and output receptacle fusing.

OPTIONS AVAILABLE IN THE CASE

- Solid State Relay (See page P-58)
- Recorder Output
- 4-20 mA Output
- Audible Alarm (see page P-57)
- Remote Alarm Reset
- Consult Sales Dept. for availability and pricing

Controllers Available

Digital Display Models	Section, Page
4001, 4002	P-8
4201, 4202	P-11
6000	P-16
D921, D922	P-19
8000	P-27
1600	P-35
149, 150	P-51
Analog Display Models	
I921, I922	P-20
E924, E922	P-21
6102, 6103	P-32
1500	P-36
1400	P-37
20, 20M	P-40
49, 50	P-53

Hundreds of Styles Available to Suit Your Every Need!

How To Order:
On the appropriate pages shown, select one of the indicated OMEGA controllers, being sure to specify range and desired options (where applicable). Add the prefix CS to the controller model number.

Pricing:
Single Set Point Models: Add $125 to the total price of the controller.

Dual Set Point Models: Add $140 to the total price of the controller.

Example:
CS-4002-KF-T (shown) is a 4002 dual set point controller with a type K thermocouple input, a temperature range of **0 to 1999°F**, and the solid state Triac relay option.

Total Cost: $140 + $320 = $460

Audible Temperature Alarm

Works with any OMEGA® Temperature Controller

Shown much larger than actual size to show detail.

Two Styles—Continuous and Intermittent Tone

- **Loud Tone—95 dB at 2900 Hz**
- **Solid State Reliability—No Arcing or Mechanical Wear**
- **Easy to Install**

The OMEGA Model 70 Temperature Alarms are the latest development in solid state sound production. When power is applied to them, a piezoelectric transducer operates as a solid state oscillator resulting in a loud, audible alarm tone.

Rugged! There is no arcing or mechanical wear. The OMEGA Temperature Alarms are designed to give years of trouble-free service. They are easy to install. Only a 1³⁄₁₆″ diameter hole is required. Easy to operate. Simply connect to a temperature controller and 120 volts ac.

Surge Voltage—15% over maximum rated voltage applied for less than one minute

Life Specifications

Continuous—100 hours continuous operation at 65°C with maximum rated voltage applied

Intermittent—A duty cycle of 1 minute on, 5 minutes off, a minimum of 5000 times at room temperature and maximum rated voltage applied.

Life Expectancy—Five years under normal operating conditions

Storage Temperature—
−40°C to +85°C

Operating Temperature—
−30°C to +65°C

Humidity

The Model 70 Temperature Alarm should operate after having been subjected to 95% relative humidity at +40°C continuously for 100 hours. After removal from high humidity, the unit should be allowed to dry for a minimum of four hours at room temperature before operation.

+225
°C
SET POINT
OMEGA

Series **920 OMEGA Temperature Controller** pictured with **Model 70-1 alarm.**

$15 (**Model 70-1** pictured)

Probe not included

HOW TO ORDER

Description	Catalog No.	Sound Level	Price
Continuous tone	70-1	95 dB at 2900 Hz	$15
Fast pulse tone	70-2	95 dB at 2900 Hz	$16
Slow pulse tone	70-3	95 dB at 2900 Hz	$16

READ
SET
752 °C
OMEGA

OMEGA
ENGINEERING, INC.
STAMFORD, CONN.
1
2
°C x100

OMEGA®
Series "SSR" High-Reliability Solid State Relays

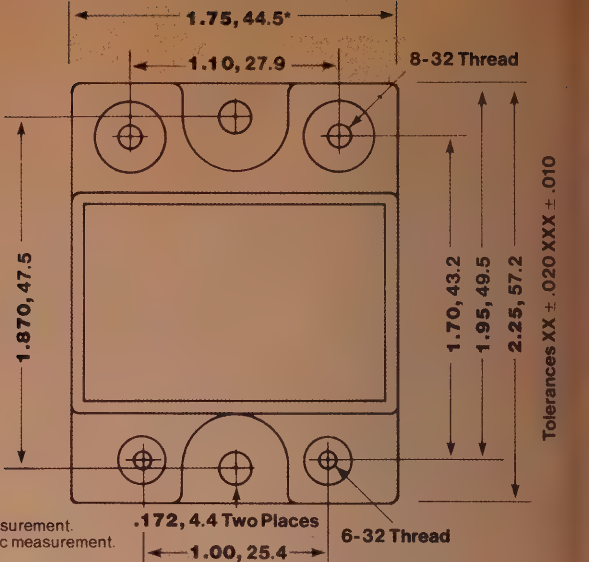
Control Resistant Heaters up to 10 KW using OMEGA® Solid State Relays in conjunction with lower-rated temperature controllers.

- High Reliability
- Multi-million cycle life
- Compatible with **OMEGA**® Temperature Controllers
- Solid State, SCR Design
- Zero Voltage Switching
- UL Recognized and CSA Certified
- For 120-240 V ac Applications
- AC and DC Control Signal Models
- 200% Testing at Rated Current

Prices start at
$21

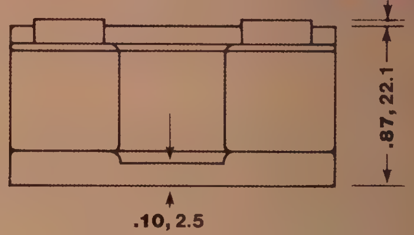
1
110/220 VAC
LOAD POWER
25 AMPS
2
OMEGA
ENGINEERING, INC.
SOLID STATE RELAY
MODEL SSR240D25
CONTROL VOLTAGE
3-32 VDC
4
3

LOAD POWER
110/220 VAC
25 AMPS
OMEGA ENGINEERING, INC.
SOLID STATE RELAY
MODEL SSR240D25

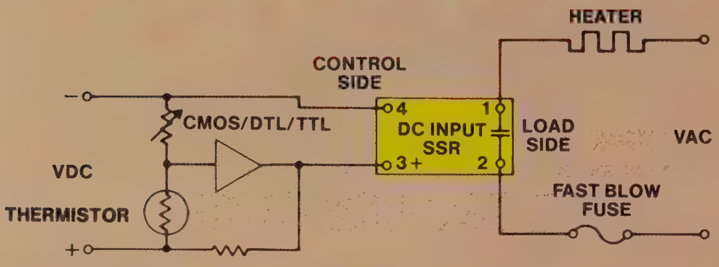

1.75, 44.5*
1.10, 27.9
8-32 Thread
1.870, 47.5
1.70, 43.2
1.95, 49.5
2.25, 57.2
Tolerances XX ± .020 XXX ± .010
.172, 4.4 Two Places
1.00, 25.4
6-32 Thread

*Bold type is Std. measurement.
Medium type is metric measurement.

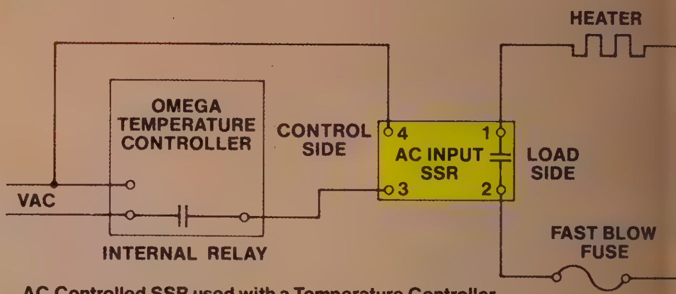
.010, .25 Clearance For Circuit Board Mounting



OMEGA "SSR" Solid State Relay


HEATER
CONTROL SIDE
CMOS/DTL/TTL
VDC
THERMISTOR
4
1
DC INPUT SSR
3 +
2
LOAD SIDE
VAC
FAST BLOW FUSE

DC Controlled SSR used with a solid state logic Control Circuit


HEATER
OMEGA TEMPERATURE CONTROLLER
CONTROL SIDE
4
1
AC INPUT SSR
3
2
LOAD SIDE
VAC
INTERNAL RELAY
FAST BLOW FUSE

AC Controlled SSR used with a Temperature Controller

What is an OMEGA Solid State Relay?

An OMEGA Solid State Relay (SSR) is a single-pole, normally open, switching device with no moving parts, capable of millions of cycles of operation. By applying a control signal, the SSR switches 'ON' the AC load current, just as moving contacts do on a mechanical contactor.

"Switching" takes place at the zero voltage crossover point of the alternating current cycle. Because of this, no appreciable electrical noise is generated, making OMEGA's SSR's ideal for environments where there are computers and other apparatus which can be influenced by RF noise.

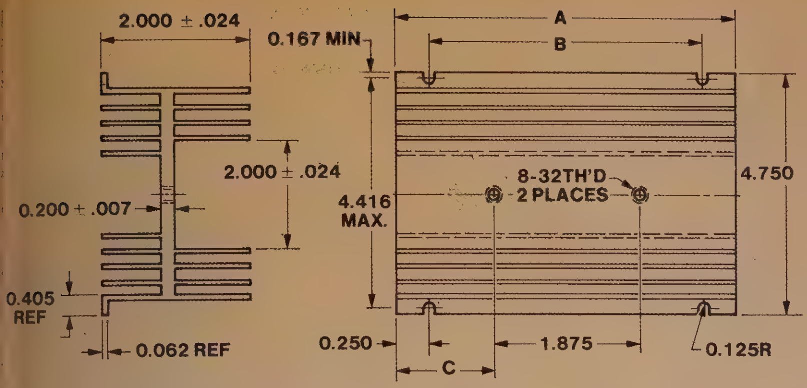
OMEGA's "SSR" Series is exclusively of the twin SCR type, which is inherently more reliable and will handle higher overloads before failure than TRIACS.

Heat is developed in a Solid State Relay due to the nominal voltage drop across the switching device. To dissipate the heat, an SSR must be mounted on a finned heat sink or an aluminum plate. An SSR should be located where the ambient temperature is relatively low, since the current switching rating is lowered as temperature increases. Another SSR characteristic is a small, 7-15 mA, current leakage across the output when the relay is "OPEN". Because of this, a voltage will always

Electrical Specifications of OMEGA Solid State Relays

		INPUT-CONTROL SIGNAL					INPUT & OUTPUT
Model	Type	Control Signal Voltage Range	Control Signal Turn-On Voltage	Control Signal Turn-Off Voltage	Signal Input Impedance	Standard Isolation Voltage	Peak Repetitive Voltage Minimum*
SSR 240 A10 SSR 240 A25 SSR 240 A45	AC Control Signal	85 to 280VAC	85 VAC	10VAC	33 k Ω	2500V RMS	500V
SSR 240 D10 SSR 240 D25 SSR 240 D45	DC Control Signal	3 to 32VDC	3 VDC	1VDC	1000 Ω	2500V RMS	500V

*Transients above 500V should be suppressed.

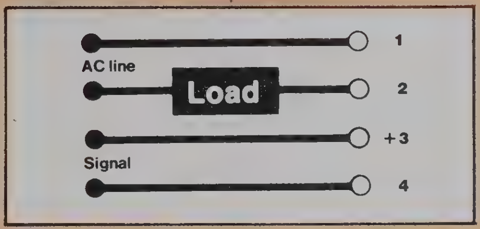

2.000 ± .024
0.167 MIN
A
B
2.000 ± .024
8-32TH'D
2 PLACES
4.750
4.416
MAX.
0.200 ± .007
0.405
REF
0.062 REF
0.250
1.875
0.125R
C

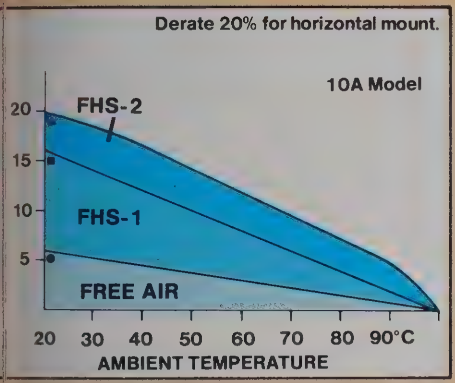
110/220 VAC
LOAD POWER
25 AMPS
OMEGA
ENGINEERING, INC.
SOLID STATE RELAY
MODEL SSR240D25
CONTROL VOLTAGE
3-32 VDC

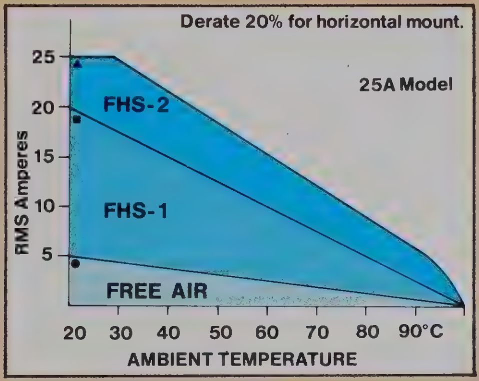
MEGA finned heat sinks (FHS) are anodized aluminum fabrications d come complete with tapped mounting holes and screws. See hermal Rating Curve" and "How to Order" instructions for selection.

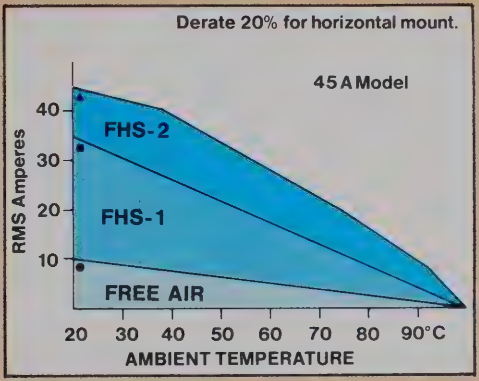
	A	B	C	THERMAL RATING
HS 1	3.00	2.50	.56	2°C/W
HS 2	5.50	5.00	1.81	1.2°C/W

Connection Diagram


1
AC line
Load
2
+3
Signal
4







ree Air
Mounted on a FHS-1 or a 6" x 6" plate (2° c/watt)
Mounted on a FHS-2 or a 12" x 12" plate (1.2° c/watt)

xist on the load side of the device.

Solid State Relay cycle life is many times that of an quivalently priced mechanical contactor. OMEGA commends Solid State Relays for use with proportional mperature controllers and other applications where ng life and solid state reliability are needed.

In contrasting Solid State Relays with mechanical conctors, it should be noted that a Solid State Relay is ore prone to failure due to overload and improper initial iring. Solid State Relays can fail, *contact closed,* on verloaded circuits.

Additional Specifications (All Models)

Isolation: Input-to-output and input-to-base: 2500 VAC 10^{10} ohms DC. Coupling capacitance input-to-output: 8 pf. max.
Operating Temp.: −40 to 100°C.
Operating Freq.: 47 to 400 Hz.
Turn-on Time: 1/2 cycle maximum, zero voltage.
Turn-off Time: 1/2 cycle maximum, zero current.
DV/DT-off State: 200V/usec
DV/DT-Commutating: Snubbed for rated current at 0.5 power factor.

OUTPUT-AC LOAD SIDE					θjc °C/W (see note)	Dissipation Watts/Amps
Nominal AC Line Voltage Range	Nominal Load Current	Maximum Contact Voltage Drop	Maximum Off-State Leakage 120V	240V		
12 to 280VAC	10A 25A 45A	1.6V	4.5mA 7.5mA 7.5mA	9mA 15mA 15mA	1.3 1.2 0.67	1.6 1.3 0.9
12 to 280VAC	10A 25A 45A	1.6V	4.5mA 7.5mA 7.5mA	9mA 15mA 15mA	1.3 1.2 0.67	1.6 1.3 0.9

Surge Current Data

Time Seconds	No. of Cycles at 60 Hz	Peak Amps 10A SSR	25A SSR	45A SSR
0.017	1	110	250	650
0.100	6	70	140	320
0.500	30	50	80	175
1.0	60	40	67	134
2.0	120	33	53	119
4.0	240	31	47	95
10.0	600	28	42	84

Note: θjc = Thermal resistance junction to base. Maximum junction temperature = 110°C.

How to Order

Relay Selection Guide (Please read this before you order.)

OMEGA offers six (6) SSR models: Three for AC input control signals; three for DC input control signals. Each family of 3 have nominal ratings of 10, 25 and 45 amps and are for switching heaters and other devices on *either* 120 VAC or 240 VAC power lines. The AC control models are compatible with OMEGA temperature controllers listed on the right. DC signal control models are compatible with DTL, TTL, CMOS Logic.

1. Use Application Rating Guide below to select the SSR catalog number which will meet your control signal and amperage switching requirements.
2. Determine maximum ambient temperature where the SSR will be mounted.
3. Use Thermal Rating Curves, Page P-60, to determine the proper heat sink. Locate the maximum ambient temperature on the horizontal temperature axis and follow its vertical line upward until it intersects with the load current's horizontal line. The heat sink required is shown by the curve which is above the intercept of the two lines.
   a. If the intercept is above the top curve, use the next higher current rated SSR and repeat step 3.
   b. If the intercept is above the middle curve, but below the top curve, an OMEGA FHS-2 heat sink or a 12″ x 12″ x 1/8″ aluminum plate should be used.
   c. If the intercept is above the lowest curve, but below the middle curve, an OMEGA FHS-1 or 6″ x 6″ x 1/8″ aluminum plate should be used.
   d. If the intercept is below the lowest curve, the SSR can be used in free air with no heat sink.
4. It is essential that a properly rated, fast blowing (I^2T) fuse be installed to protect the load circuit. Recommended part numbers are listed in the Application Rating Guide. OMEGA recommends Solid State Relays to those customers who have existing electrical skills with this type of device.

OMEGA Solid State Relays are compatible with ALL OMEGA relay and triac output temperature controllers listed below.
See this section for additional information on these controllers.

Models: 4001, 4002, 4201, 4202 exclusive of Option "F" *(for option "T" see note)*

Models: 49, 50, 56, 57, 58 exclusive of Option 844 *(for option 813 see note)*

Models: 148, 149, 150, 156, 157, 158, 159, 164, 165, 166 *(for option 713 see note)*

Models: 800M, 801M, 802M, 803M, 8000M, 8020M, 402, 4020

Models: 20, 22 *(see note)*

NOTE: For controller models with a triac output, a resistor must be placed across the control side of the SSR to drain the leakage current from the controller's triac, otherwise the SSR will not function properly. Detailed information on determining resistor values are included in the instruction booklet supplied with each SSR.

Applications Rating Guide

	AC CONTROL SIGNAL MODELS						DC CONTROL SIGNAL MODELS					
Catalog Number	**SSR 240 A10**		**SSR 240 A25**		**SSR 240 A45**		**SSR 240 D10**		**SSR 240 D25**		**SSR 240 D45**	
AC Voltage	**120V**	**240V**	**120V**	**240V**	**120V**	**240V**	**120V**	**240V**	**120V**	**240V**	**120V**	**240V**
Resistance Heater On/Off Control Proportional Control (See Note 2)	12 amps 10 amps		20 amps 16 amps		45 amps 35 amps		12 amps 10 amps		20 amps 16 amps		45 amps 35 amps	
Infrared Heater (Tungsten/Quartz)	8.3 amps (1kW)	(2kW)	16.7 amps (2kW)	(4kW)	35 amps (3kW)	(6kW)	8.3 amps (1kW)	(2kW)	16.7 amps (2kW)	(4kW)	35 amps (3kW)	(6kW)
1 Phase Motors (See Note 1)	1/4HP	1/3HP	1/3HP	1/2HP	3/4HP	1-1/2HP	1/4HP	1/3HP	1/3HP	1/2HP	3/4HP	1-1/2HP
3 Phase Motors (See Note 1)	—	3/4HP	—	2HP	—	3HP	—	3/4 HP	—	2HP	—	3HP
Incandescent Lamps	8.3 amps (1kW)	(2kW)	16.7 amps (2kW)	(4kW)	35 amps (3kW)	(6kW)	8.3 amps (1kW)	(2kW)	16.7 amps (2kW)	(4kW)	35 amps (3kW)	(6kW)
Transformers	500W	1kW	1kW	2kW	2kW	4kW	500W	1kW	1kW	2kW	2kW	4kW
Solenoids	6 amps		8 amps		16 amps		6 amps		8 amps		16 amps	
Recommended Fuses (See Note 3)	Fast Blow KAX-10 $6		Fast Blow KAX-25 $6		Fast Blow KAX-30 $6		Fast Blow KAX-10 $6		Fast Blow KAX-25 $6		Fast Blow KAX-30 $6	

Catalog No. and Prices

Description	Catalog No.	Nominal Rating	Price
AC Control Signal	SSR 240 A10 SSR 240 A25 SSR 240 A45	10A 25A 45A	$27 $37 $50
DC Control Signal	SSR 240 D10 SSR 240 D25 SSR 240 D45	10A 25A 45A	$21 $26 $47
Finned Heat Sinks	FHS 1 FHS 2	2°C/W 1.2°C/W	$13 $17

GENERAL NOTE: Above load ratings assume adequate heat sink area in accordance with thermal rating graphs, Page P-60

NOTE 1: Motor Load: It is only necessary to switch two lines on a 3-phase motor, although switching 3 lines reduces voltage across SSR. If the motor has a high inertia load, it is possible during "turn off" to generate a voltage across the SSR as high as 150% of the line voltage. For reversing 3 lead (permanent split phase capacitor) type motors, use 240V relays on 120V lines. For 240V lines, refer to factory.

NOTE 2: Six cycles per minute or less.

NOTE 3: Bussman or Equivalent: It is essential that a proper Fast Blow ($I^2=T$) Fuse is used. SSR's normal failure mode on overloaded circuits is closed contacts (ON).
Fuse Blocks: 1, 2, or 3 Pole FB-1, $5; FB-2, $10; FB-3, $16.

1000
1500
2000
500
2500
0
°F
TYPE K
OMEGA ENGINEERING, INC.
SET II
SET I
READ
320 °C
OMEGA

Magnetic Contactors

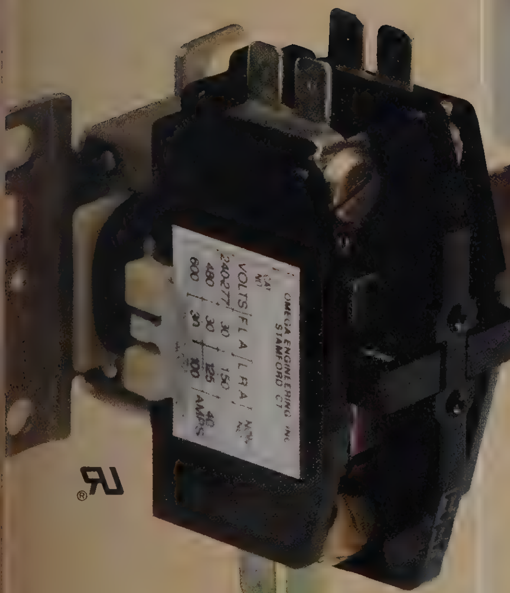
Special Purpose Contactors for High Power Temperature Control

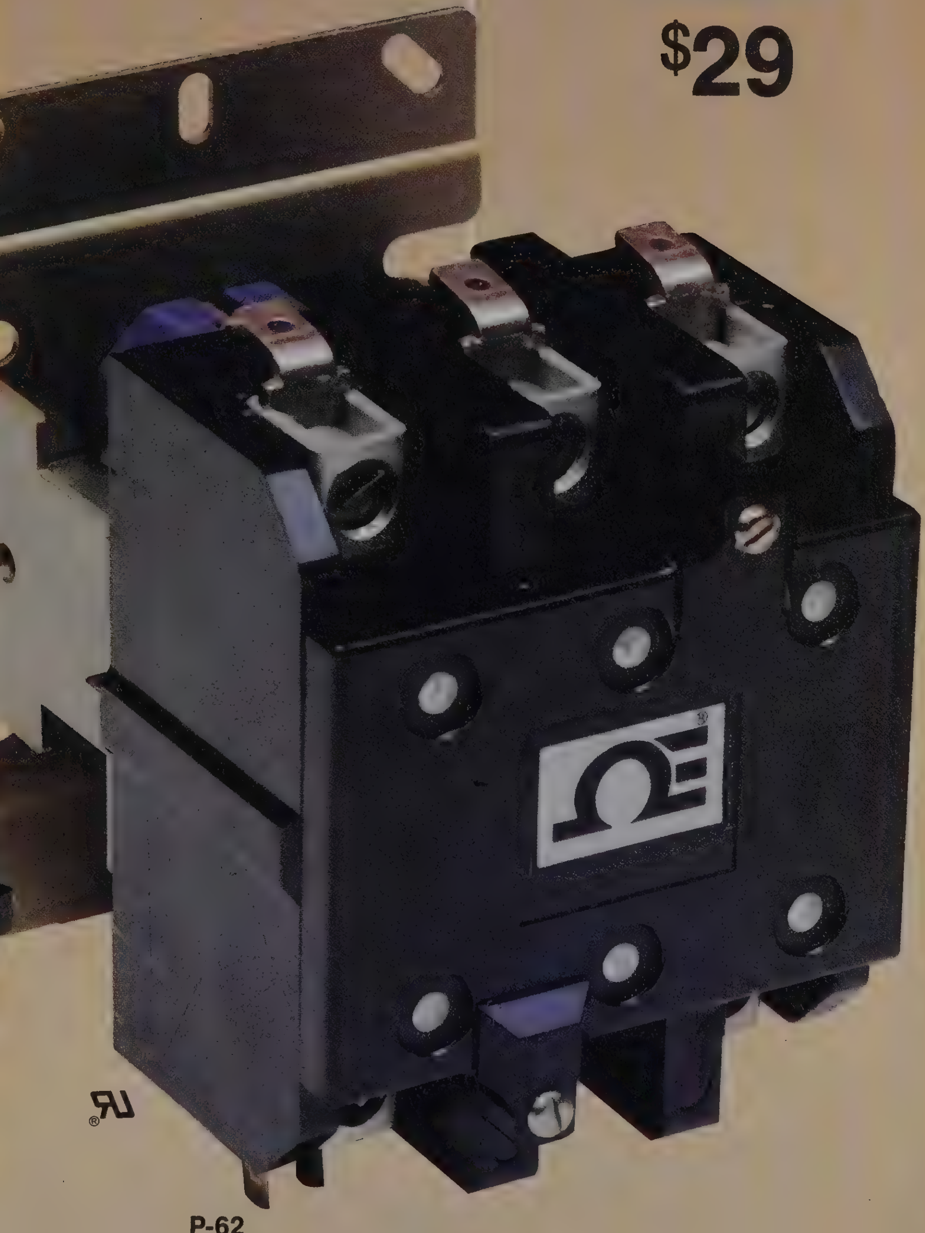
Control resistance heaters up to 75 amps using OMEGA Temperature Controllers and Magnetic Contactors.

- Long Life—Over 500,000 Operations
- 30 to 75 Amps
- Heavy Duty Construction
- Easy Mounting
- 600 V ac Contacts

Prices start at

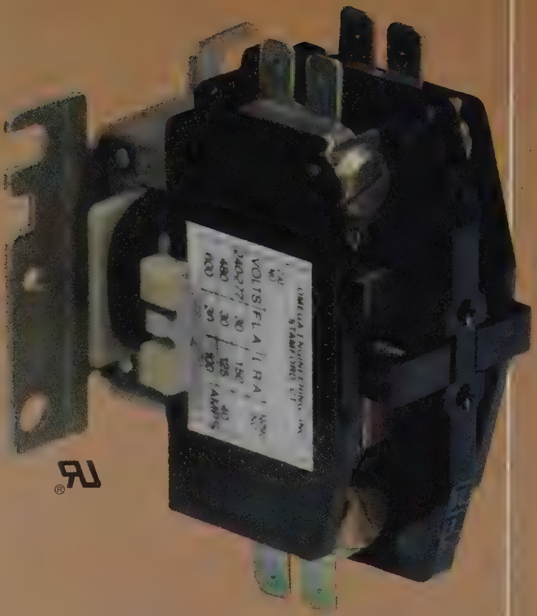
$29


OMEGA ENGINEERING, INC.
STAMFORD CT
VOLTS
F.L.A.
L.R.A.
240/277
480
600
AMPS



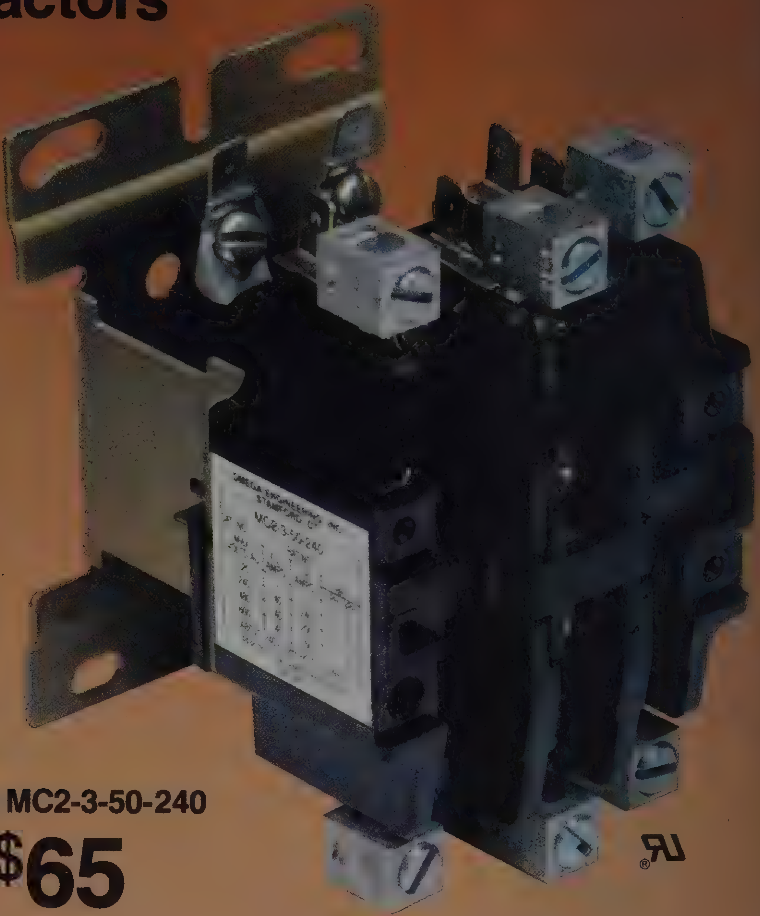
Magnetic Contactors

Special Purpose Contactors for High Power Temperature Control



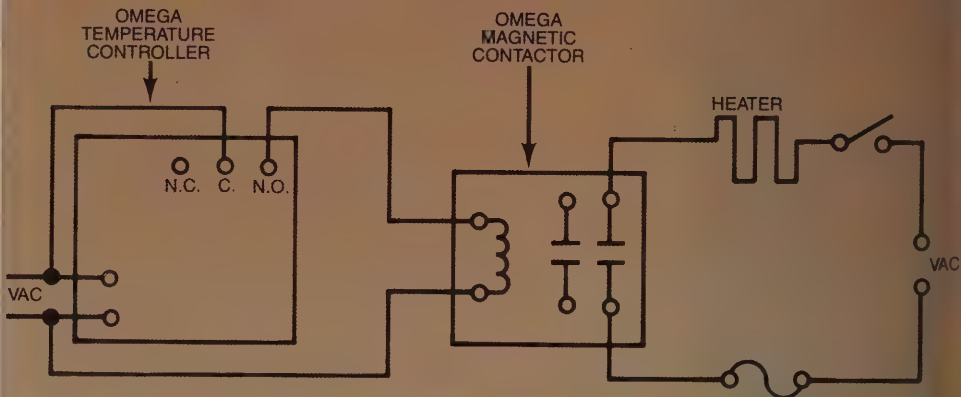
Model MC1-2-30-120

$29



Model MC2-3-50-240

$65


OMEGA TEMPERATURE CONTROLLER
OMEGA MAGNETIC CONTACTOR
HEATER
N.C.
C.
N.O.
VAC
VAC
FUSE

MAGNETIC CONTACTOR USED WITH A TEMPERATURE CONTROLLER

Applications Rating Guide

Catalog Number	MCI-2-30-120 -240	MC2-2-40-120 -240	MC2-3-40-120 -240	MC2-3-50-240	MC3-3-75-240
Non-inductive Amps	30	40	40	50	75
Full Load Amps	20	30	30	40	60
Locked Rotor Amps at 240 V	120	180	180	240	360
480 V	100	150	150	200	300
600 V	80	120	120	160	240
No. of Poles	2	2	3	3	3
Wire Size	16-8	16-8	16-8	14-6	14-2

NOTE 1: Contacts are rated to 600 V ac.
NOTE 2: Poles cannot be used in parallel to increase current rating.
NOTE 3: Relays do not provide overload protection for motors.
NOTE 4: Relays must be mounted vertically.

Control Resistance Heaters up to 75 Amps

lechanical Contactors or Temperature Control

he OMEGA Mechanical Contactors
re designed to be used indepen-
ently with 120 and 240 V ac control
gnals or with any of the OMEGA
emperature controllers.

he OMEGA special purpose con-
actors provide the process industry
ith exceptionally reliable control for
eating and cooling applications.
ong electromechanical life is
ssured by extra electrical capacity
nd short stroke magnet design.
ilver-cadmium oxide contacts have
uperior weld resistant character-
tics, high conductivity and high
esistance to arc erosion. The spe-
ially designed contact spacing gives
rc over protection up to 600V ac.

nstallation is simplified because
erminal and mounting screws are
ccessible from the same direction.
ontactors are designed to be
ounted vertically either exposed,
existing equipment, or individually,
sing NEMA 1 enclosures, Catalog
lo. EN-MC2.

Catalog No. and Prices

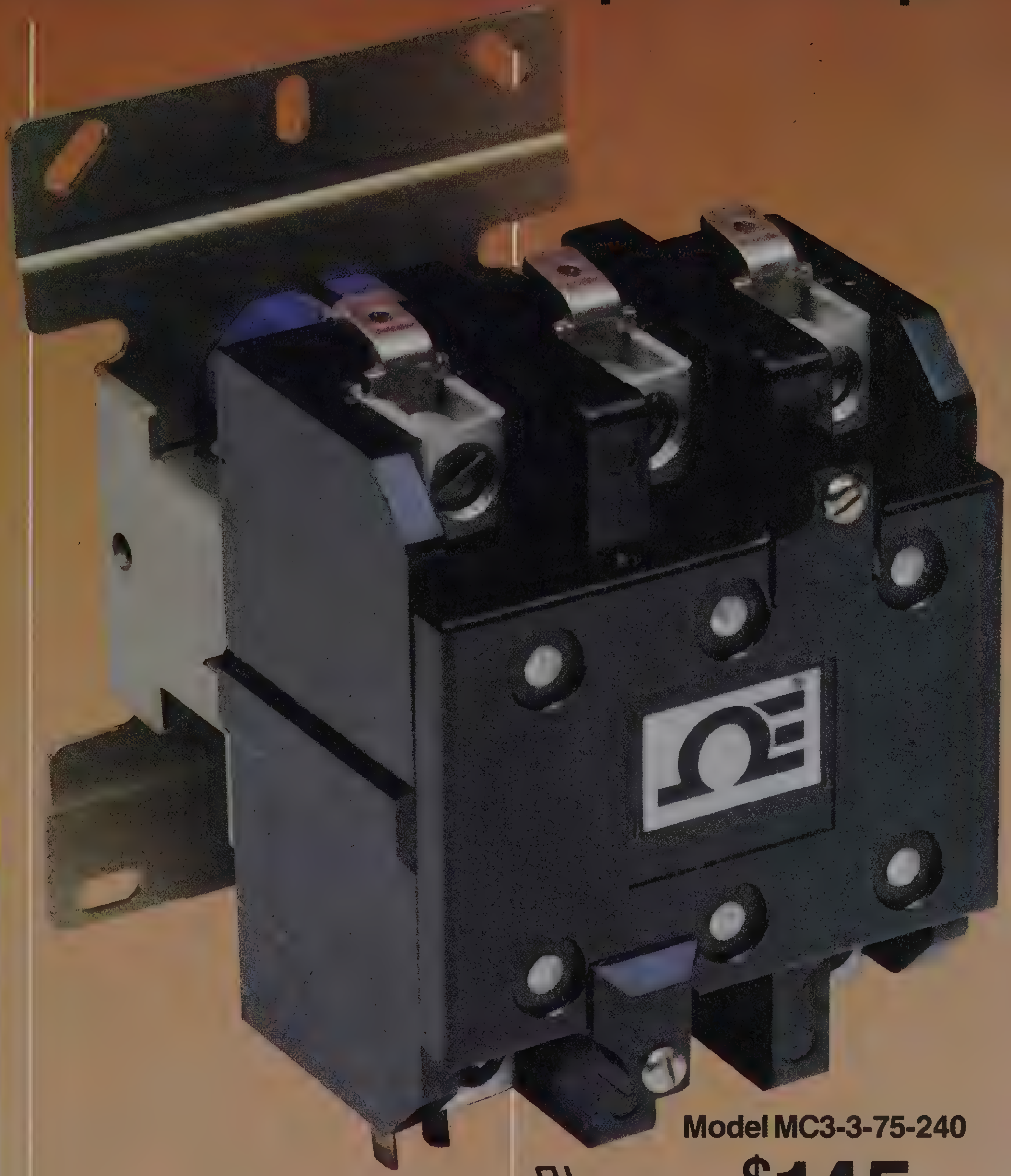
Catalog No.	Price
MC1-2-30-120	$ 29
MC1-2-30-240	29
MC2-2-40-120	49
MC2-2-40-240	49
MC2-3-40-120	55
MC2-3-40-240	55
MC2-3-50-240	65
MC3-3-75-240	145

How To Order

Select:
1. Style
2. Determine No. of Poles
3. Full Load Amps
4. Coil Voltage

MC [1]—[2]—[3]—[4]

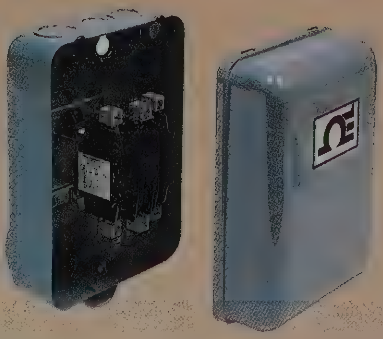
Style — [1]
No. of Poles — [2]
Full Load Amps — [3]
Coil Voltage — [4]



Model MC3-3-75-240

$145

NEMA 1 General Purpose Enclosure for Mounting Contactors



Catalog No. EN-MC2

Price $20

Mounting Holes: Keyhole slots and regular holes are embossed to facilitate mounting on uneven wall surfaces.

Knockouts: NEMA 1 enclosures have ample knockouts for wiring.

General: Enclosures are drawn steel with a baked gray acrylic lifetime finish.

The enclosures are not water or dust tight. They are intended for indoor use only.

Fits MC2 style contactors.

OMEGA ENGINEERING, INC.
OMEGAN TEST KIT
OMEGA ENGINEERING, INC.
INSTRUCTIONS
MELTING PO
STANDARD
Low Vapor Pressure S
300°F INDICATING CRAYON
500°F TEMPERATURE
425°F TEMPERATURE
REVERSIBLE TEMPERATURE INDICATOR
MODEL RLC-1
OMEGA ENGINEERING, INC.
DIRECTIONS FOR USING
OMEGALABELS
OMEGALABEL
PEEL THIS STRIP BACK TO REMOVE

OMEGALAQ™
450°F
232°C
977°F
525°C
650°F
343°C
OMEGASTIK™
OMEGASTIK™
OMEGASTIK™
OMEGASTIK™
OMEGA

Q

Temperature Sensitive Products

Crayons Pellets Lacquers Q-3

Irreversible Labels and Monitors Q-4

Melting Point Standards Q-7

Non-Reversible Temperature Labels Q-10

Reversible Temperature Labels Q-12

Liquid Crystal Thermometers Q-16

Temperature Indicating Tabs, Crayons, Lacquers, and Pellets

FOR TECHNICAL USE ONLY
OMEGAPELLETS™
1250°F
677°C
OMEGA ENGINEERING INC
OMEGALAQ™
438°F
226°C
TEMPERATURE INDICATING LIQUID
LEAD FREE
SULFUR FREE
OMEGASTIK™

OMEGASTIK™

Description: A temperature melt material in stick form.

General directions for use: Suitable for both smooth and rough surfaces and for determining all temperatures. Comes in an adjustable metal holder. Stroke workpiece with the proper OMEGASTIK™ from time to time during heating. Below its temperature rating, the OMEGASTIK™ leaves a dry (chalky) mark; when its rating is reached, the OMEGASTIK™ leaves a liquid smear.

Alternative method: Can be used for determining temperatures below 700°F; and when heating rapidly to higher temperatures.

Mark workpiece with appropriate OMEGASTIK™ before heating begins. When its stated temperature is reached, the mark liquefies.

If the surface is too smooth to be distinctly marked (while cool) with an OMEGASTIK™, the use of OMEGALAQ™ is recommended.

Uses: In welding, forging, heat-treating and fabrication of metals; molding of rubber and plastics; and generally for applications where the workpiece is accessible.

Time Response: On the order of milliseconds (.001 secs).

Maximum Range: 2500°F

Accuracy: ± 1.0%

$5.50 each in adjustable metal holders

OMEGAPELLETS™

Description: A temperature melt material in pellet form.

Directions for Use: Place appropriate pellet on workpiece before heating begins. When the very first sign of melting appears, the temperature rating of the pellet has been reached.

In Reducing Atmospheres Special Series "R" OMEGAPELLETS™ should be used. Data sheet available upon request.

Uses: For checking furnace temperatures and for applications which involve heating of long duration, as in the heat treating of large units.

Size: Standard OMEGAPELLETS™ are $\frac{1}{8}''$ × $\frac{7}{16}''$. Special miniature pellets, $\frac{1}{8}''$ × $\frac{1}{8}''$, are also available at the same price, in all the temperatures listed for the standard OMEGAPELLETS™. Use suffix M for ordering miniature pellets.

Maximum Range: 2500°F

Accuracy: ± 1.0%

$5.50 per tube of 20 pellets

Series "R"
$6.50 per tube of 20 pellets
Also Available:
Cups to hold pellets: **$7.30/100**

User Note:

Important caution: Disregard color changes. Temperature signal is the melting of stick, lacquer, or pellet. Not any change of color during heating.

OMEGASTIK™, OMEGALAQ™, OMEGALABEL™, and OMEGAPELLETS™ are trademarks of OMEGA ENGINEERING, INC.

OMEGALAQ™

Description: Same material used in pellets and sticks in lacquer suspension. Lacquer serves transport function only. Thinning OMEGALAQ™ will not affect accuracy.

Directions for use: Shake or stir to uniform consistency. Apply thin smear to the working surface before heating begins. It dries almost instantly to a mark. When the stated temperature is reached on subsequent heating, this mark liquefies sharply. A melted OMEGALAQ™ coating does not revert to its original dull-opaque appearance but remains glossy-transparent—which makes subsequent interpretation a simple matter.

Uses: For application to fabrics, rubber, plastics and smooth surfaces, like glass or polished metal—on which **OMEGASTIK™** may not leave a distinct mark, or cannot conveniently be used.

Widely accepted for monitoring temperatures in the electronics field.

Time Response: On the order of milliseconds (.001 secs)

Maximum Range: 2500°F

Accuracy: ± 1.0%

OMEGALAQ™

2 oz. Bottle	**$ 5.50**
Pint	**32.00**

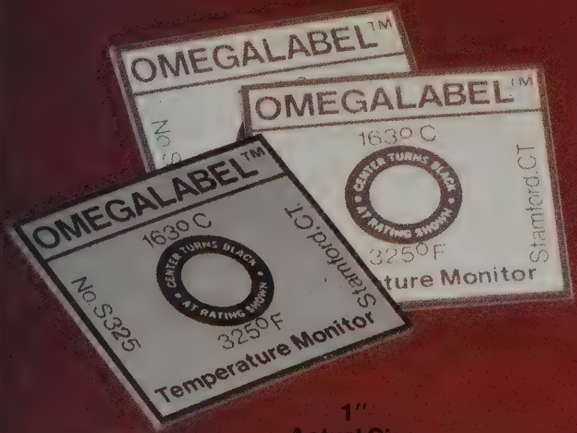
OMEGALAQ™ may be thinned to ensure workable consistency.
OMEGALAQ™ 100° F to 109°F: Use Water
OMEGALAQ™ 113°F to 194°F: Order Blue Label
OMEGALAQ™ 200°F to 2500°F: Order Red Label

THINNER

2 oz. Bottle	**$ 2.75**
Pint	**13.50**

OMEGALABELS™

Minimum Order: 10 OMEGALABELS™ of a single part number.



1"
Actual Size

OMEGALABEL™
PART NO 6MA 100-38
38°C 43°C 49°C 54°C 60°C 66°C
100°F 110°F 120°F 130°F 140°F 150°F

Actual Size
overall: ⅜" H × 1¼" W
Indicating Window: ⅛" H × 1/16" W

OMEGASTIKS™ OMEGALAQ™ OMEGAPELLETS™

Available in the following degrees

°F	°C	°F	°C	°F	°C
100	38	306	152	1022	550
103	39	313	156	1050*	566
106	41	319	159	1100	593
109	43	325	163	1150	621
113	45	331	166	1200*	649
119	48	338	170	1250*	677
125	52	344	173	1300*	704
131	55	350	177	1350*	732
138	59	363	184	1400*	760
144	62	375	191	1425	774
150	66	388	198	1450*	788
156	69	400	204	1480	804
163	73	413	212	1500*	816
169	76	425	218	1550	843
175	79	438	226	1600	871
182	83	450	232	1650	899
188	87	463	239	1700	927
194	90	475	246	1750*	954
200	93	488	253	1800	982
206	97	500	260	1850	1010
213	101	525	274	1900*	1038
219	104	550	288	1950	1066
225	107	575	302	2000	1093
231	111	600	316	2050	1121
238	114	625	329	2100	1149
244	118	650*	343	2150*	1177
250	121	700	371	2200*	1204
256	124	750*	399	2250*	1232
263	128	800*	427	2300*	1260
269	132	850*	454	2350*	1288
275	135	900	482	2400	1316
282	139	932	500	2450	1343
288	142	950	510	2500*	1371
294	146	977	525		
300	149	1000	538		

* Series "R" OMEGAPELLETS™ are available in these temperatures only. For 550°F and below, regular OMEGAPELLETS™ can be used for reducing atmospheres.

OMEGALABEL™

OMEGALABEL™ irreversible self-adhesive temperature monitors consist of one or more heat-sensitive indicators sealed under transparent, heat-resistant windows. The centers of the indicator circles will turn black at the temperature ratings shown on the label. The change to black is irreversible and registers the temperature history of the workpiece. The exposed OMEGALABEL™ can be made part of the permanent record by removing it and affixing it to the service report. These conveniently applied and easy-to-interpret temperature indicating tabs find many industrial and military uses, as well as applications in research and development programs. The OMEGALABEL™ will indicate a specified temperature or sequence of temperatures, with a tolerance of plus or minus one percent of the stated temperature rating. The performance of the OMEGALABEL™ is not affected by transient contact with solvents, gasoline, fuel oil, lubricants, hot water, or steam. The OMEGALABEL™ should be evaluated for applications where it is inadvisable to use the OMEGASTIK™, OMEGALAQ™, or OMEGAPELLETS™. The OMEGALABEL™ is particularly useful in the solution of problems, which include: monitoring the safe operating temperature of equipment and processes; determining temperatures as a guide to design and material selection in research and development projects; safeguarding temperature-sensitive materials in storage and transit; obtaining operating temperature data of components and regions not readily accessible to other methods. To use the OMEGALABEL™, remove the backing, exposing the adhesive; press the OMEGALABEL™ firmly to the work surface. No special treatment is needed for the surface, although it should be clean and dry to obtain maximum adhesion.

Accuracy: ± 1.0%

Typical Applications

Machinery and Equipment
Bearings, gear boxes, transmission housings, heat exchangers, radiators.

Electrical Apparatus
Generators, transformers, rectifiers, motor casings and bearings, metal or plastic appliances.

Electronic Assemblies
Tubes, transformers, transistors, resistors, printed circuits, housing.

Aircraft and Rockets
Engine parts, cargo compartments, tires, brakes, heating systems, rocket chamber walls, blast tubes.

Appliance Warranties
Monitoring warranties specifying operation at safe temperatures.

Heat-sensitive Materials
Drugs, biologicals, photographic and X-ray film, foodstuffs, chemicals.

How to Order:

To order **OMEGASTIKS™, OMEGALAQ™, OMEGAPELLETS™**, specify item name and temperature in either °F or °C. Examples:

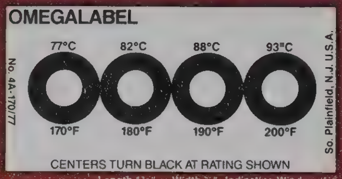
OMEGASTIKS™—113°F
OMEGALAQ™—169°F
OMEGAPELLETS™—2500°F

ORDER by the box* (10 labels to a box). See next page for part numbers and ranges available. *Sold only by the box.

NOTE: Temperature indicating labels, stiks, pellets and laquers tend to outgas in vacuum.

OMEGALABEL™—4 SERIES
Four Temperature Ratings Per Label

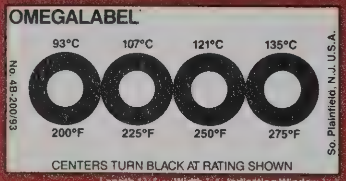
Series 4A—
(10 degree increments)
Price—$17.50/Box of 10


OMEGALABEL
77°C
82°C
88°C
93°C
170°F
180°F
190°F
200°F
No. 4A-170/77
So. Plainfield, N.J. U.S.A.
CENTERS TURN BLACK AT RATING SHOWN

Length 1¾" × Width ⅞": Indicating Window ³⁄₁₆"

Part No.	Temperature Ratings			
4A-100	100	110	120	130°F
4A-110	110	120	130	140
4A-120	120	130	140	150
4A-130	130	140	150	160
4A-140	140	150	160	170
4A-150	150	160	170	180
4A-160	160	170	180	190
4A-170	170	180	190	200
4A-180	180	190	200	210
4A-190	190	200	210	220
4A-200	200	210	220	230
4A-210	210	220	230	240
4A-220	220	230	240	250
4A-230	230	240	250	260
4A-240	240	250	260	270
4A-250	250	260	270	280
4A-260	260	270	280	290
4A-270	270	280	290	300

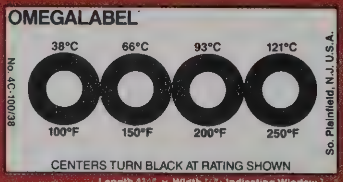
Series 4B—
(25 degree increments)
Price—$17.50/Box of 10)


OMEGALABEL
93°C
107°C
121°C
135°C
200°F
225°F
250°F
275°F
No. 4B-200/93
So. Plainfield, N.J. U.S.A.
CENTERS TURN BLACK AT RATING SHOWN

Length 1¾" × Width ⅞": Indicating Window ³⁄₁₆"

Part No.	Temperature Ratings			
4B-100	100	125	150	175°F
4B-125	125	150	175	200
4B-150	150	175	200	225
4B-175	175	200	225	250
4B-200	200	225	250	275
4B-225	225	250	275	300

Series 4C—
(50 degree increments)
Price—$17.50/Box of 10


OMEGALABEL
38°C
66°C
93°C
121°C
100°F
150°F
200°F
250°F
No. 4C-100/38
So. Plainfield, N.J. U.S.A.
CENTERS TURN BLACK AT RATING SHOWN

Length 1¾" × Width ⅞": Indicating Window ³⁄₁₆"

Part No.	Temperature Ratings			
4C-100	100	150	200	250°F
4C-150	150	200	250	300

Size of 4A, 4B, 4C: Individual Circle ³⁄₁₆" diameter; Length 1¾"; Width ⅞"

"Button" Series $25/Box of 10

Four temperature ratings on each label.
Temperatures are read clockwise starting at the "V" mark.

¼" Outside Diameter
³⁄₆₄" Indicating Windows

Part No.	Temperature Ratings							
	°F	°C	°F	°C	°F	°C	°F	°C
BU-100/38	100	38	110	43	120	49	130	54
BU-120/49	120	49	130	54	140	60	150	66
BU-140/60	140	60	150	66	160	71	170	77
BU-160/71	160	71	170	77	180	82	190	88
BU-180/82	180	82	190	88	200	93	210	99
BU-175/79	175	79	200	93	225	107	250	121
BU-225/107	215	107	250	121	275	135	300	149

"Micro-Dot" Series $11/Box of 10

(Part number is temperature rating preceded by letters MD)

³⁄₁₆" Outside Diameter
³⁄₆₄" Indicating Window

"Mini-Label" Series $8.50/Box of 10

(Part number is temperature rating preceded by letters ML)
No temperature is printed on label.

¼" Outside Diameter
¹⁄₁₆" Indicating Window

"Bulls-Eye" Series $11/Box of 10

(Part number is temperature rating preceded by letters BE)

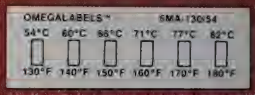
⁵⁄₁₆" Outside Diameter
⅛" Indicating Window

"Micro-Dot" Series, "Mini-Label" Series and "Bulls-Eye" Series are available in single temperature ratings listed below:

Temperature Ratings					
°F	°C	°F	°C	°F	°C
100	38	175	79	240	116
110	43	180	82	250	121
120	49	190	88	260	127
125	52	200	93	270	132
130	54	210	99	275	135
140	60	220	104	280	138
150	66	225	107	290	143
160	71	230	110	300	149
170	77				

Series 6M (Miniature) $30.25/Box of 10

Six temperature ratings on each label:
6MA-10°F between each rating
6MB-25°F between each rating

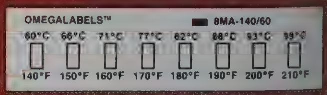

OMEGALABELS™
6MA-130/54
54°C
60°C
66°C
71°C
77°C
82°C
130°F
140°F
150°F
160°F
170°F
180°F

1¼" × ⅜"; ¹⁄₁₆" × ⅛" Indicating Windows

Part No.	Temperature Ratings										
	°F	°C	°F	°C	°F	°C	°F	°C	°F	°C	°F
6MA-100/38	100	38	110	43	120	49	130	54	140	60	150
6MA-130/54	130	54	140	60	150	66	160	71	170	77	180
6MA-160/71	160	71	170	77	180	82	190	88	200	93	210
6MA-190/88	190	88	200	93	210	99	220	104	230	110	240
6MA-220/104	220	104	230	110	240	116	250	121	260	127	270
6MA-250/121	250	121	260	127	270	132	280	138	290	143	300
6MB-100/38	100	38	125	52	150	66	175	79	200	93	225
6MB-175/79	175	79	200	93	225	107	250	121	275	135	300

Series 8M (Miniature) $41.25/Box of 10

Eight temperature ratings on each label:
8MA-10°F between each rating
8MB-25°F between each rating

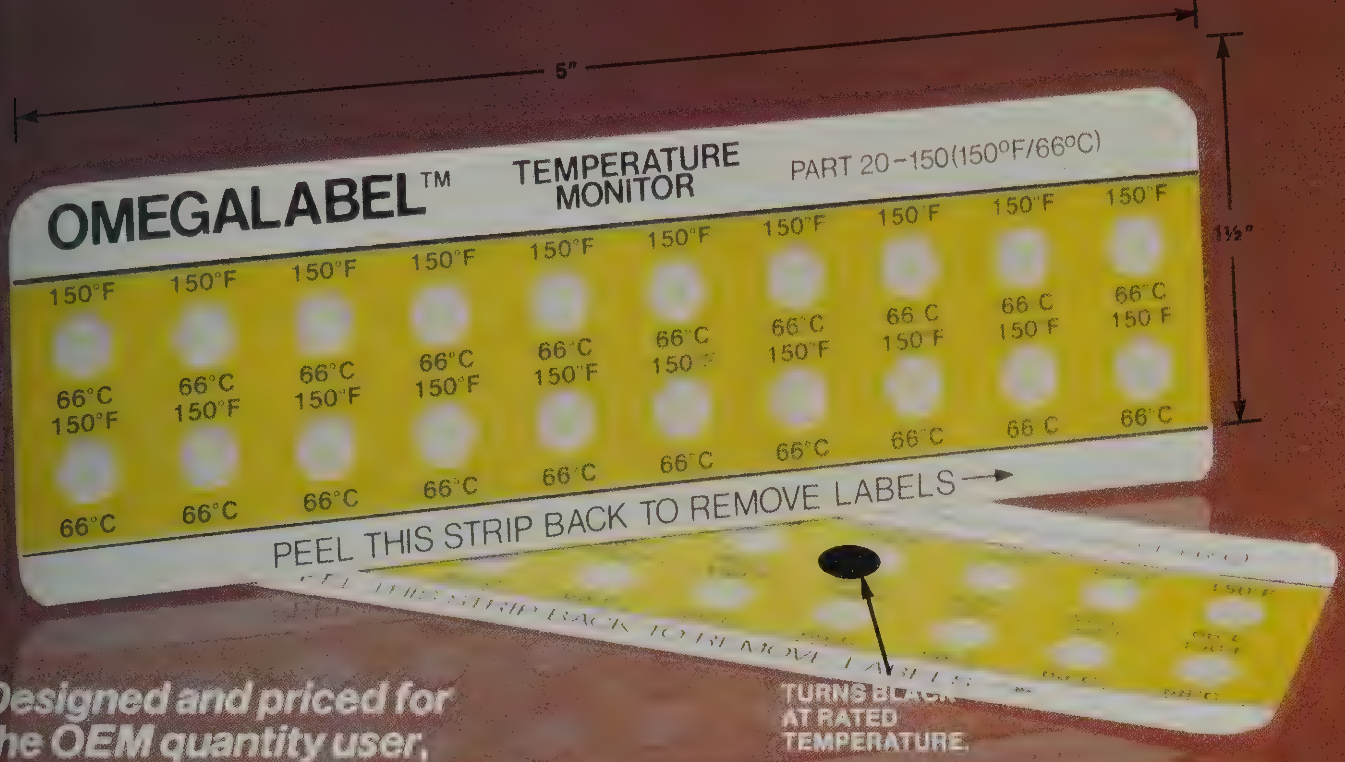

OMEGALABELS™
8MA-140/60
60°C
66°C
71°C
77°C
82°C
88°C
93°C
99°C
140°F
150°F
160°F
170°F
180°F
190°F
200°F
210°F

1⅝" × ⅜"; ¹⁄₁₆" × ⅛" Indicating Windows

Part No.	Temperature Ratings														
	°F	°C	°F	°C	°F	°C	°F	°C	°F	°C	°F	°C	°F	°C	°F
8MA-100/38	100	38	110	43	120	49	130	54	140	60	150	66	160	71	170
8MA-140/60	140	60	150	66	160	71	170	77	180	82	190	88	200	93	210
8MA-180/82	180	82	190	88	200	93	210	99	220	104	230	110	240	116	250
8MA-230/110	230	110	240	116	250	121	260	127	270	132	280	138	290	143	300
8MB-100/38	100	38	125	52	150	66	175	79	200	93	225	107	250	121	275

Labels illustrated are Actual Size

Low Cost Temperature Monitors


5"
1½"
OMEGALABEL™
TEMPERATURE MONITOR
PART 20-150(150°F/66°C)
150°F
66°C
PEEL THIS STRIP BACK TO REMOVE LABELS →
TURNS BLACK AT RATED TEMPERATURE.

Designed and priced for the OEM quantity user,

from a low of 16¢ per label to a high of 25¢ per label.

Fast, Easy-To-Use Temperature Monitoring System

OMEGALABELS™ are self-adhesive temperature monitors consisting of a heat-sensitive indicator sealed under a transparent heat-resistant window. The indicator circle turns from light grey to black at the temperature rating shown on the card. Color change is not reversible and provides a temperature history of the surface being monitored. To serve as a permanent record the OMEGALABELS™ can be removed and attached to an inspection report.

Guaranteed Accuracy and Reliability

OMEGALABEL™ accuracy is guaranteed to be within 1% of temperature rating.

Series 20 OMEGALABELS™ are conveniently mounted on dispenser card (20 per card) for fast, on-the-spot application just by peeling them off the card one at a time. The adhesive backing easily adheres to any clean, dry surface.

Series 20 Temperature Monitors

Series 20 are available in the following temperatures:

Part No.
20-100 (100°F/ 38°C)
20-110 (110°F/ 43°C)
20-120 (120°F/ 49°C)
20-130 (130°F/ 54°C)
20-140 (140°F/ 60°C)
20-150 (150°F/ 66°C)
20-160 (160°F/ 71°C)
20-170 (170°F/ 77°C)
20-180 (180°F/ 82°C)
20-190 (190°F/ 88°C)
20-200 (200°F/ 93°C)
20-210 (210°F/ 99°C)
20-220 (220°F/104°C)

Part No.
20-230 (230°F/110°C)
20-240 (240°F/116°C)
20-250 (250°F/121°C)
20-260 (260°F/127°C)
20-270 (270°F/132°C)
20-280 (280°F/138°C)
20-290 (290°F/143°C)
20-300 (300°F/149°C)
20-325 (325°F/163°C)
20-350 (350°F/177°C)
20-375 (375°F/191°C)
20-400 (400°F/204°C)

Economically priced as follows:

Quant. of Cards	Price per Card
3-9	$5.50 ($ .25 per label)
10-49	$5.00 ($ .225 per label)
50-99	$4.50 ($ .20 per label)
100-499	$4.00 ($ .18 per label)
500-1,499	$3.50 ($ .16 per label)

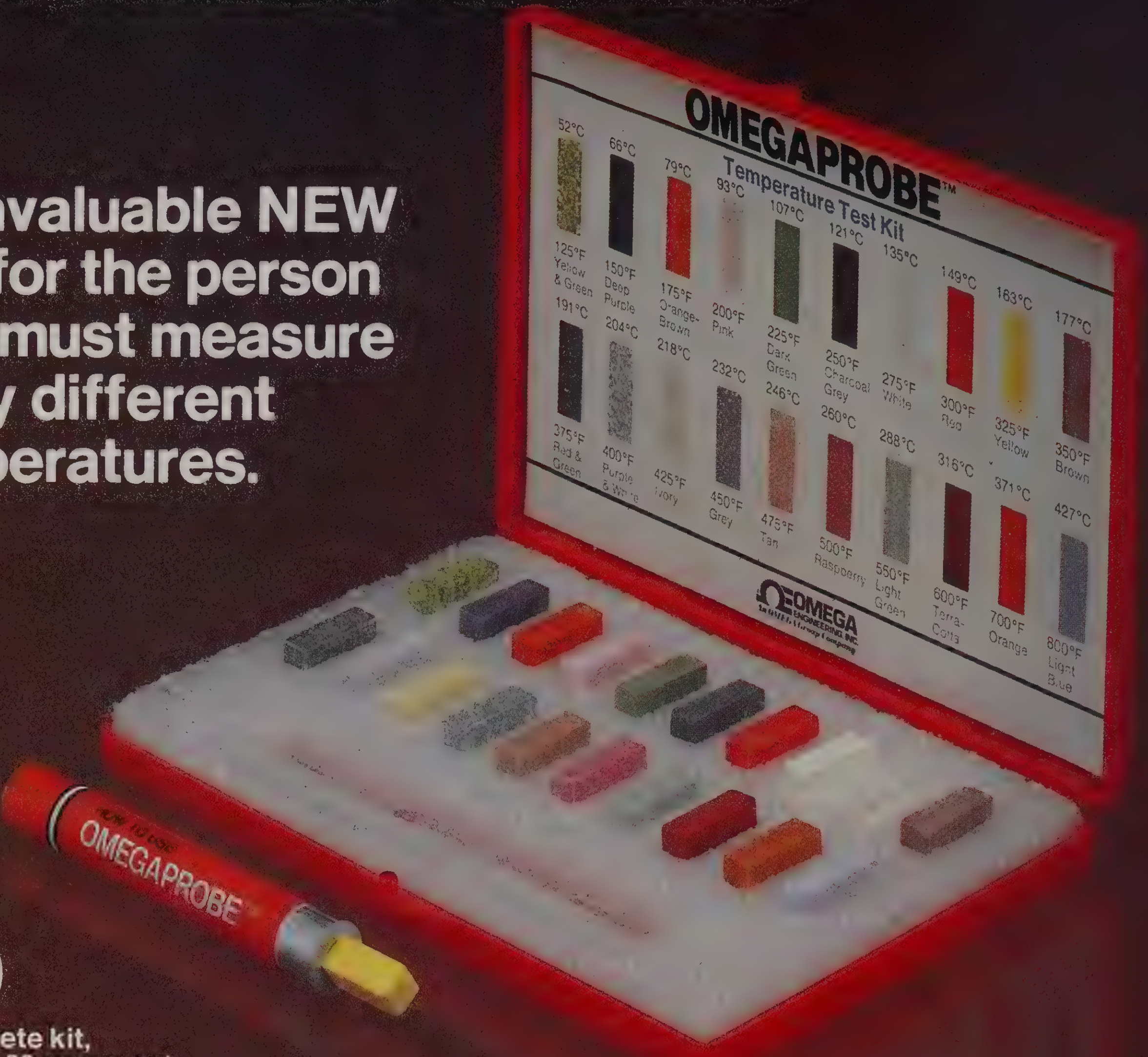
Requirements Estimator

10 cards (	$50) =	200 labels
50 cards (	$225) =	1,000 labels
100 cards (	$400) =	2,000 labels
500 cards (	$1,750) =	10,000 labels

- Standard packaging—10 cards of any temperature per box.
- Bulk packaging—500 cards of one temperature to a box.
- Minimum order: 3 cards of any temperature ($16.50) (Can be 3 different temperatures.)
- All temperatures can be combined for quantity pricing.
- Dot Dimension: ¼" diameter.
- Individual Label: ½" square.

OMEGAPROBE™ Temperature Test Kit...

An invaluable NEW tool for the person who must measure many different temperatures.


OMEGAPROBE™
Temperature Test Kit
52°C 125°F Yellow & Green
66°C 150°F Deep Purple
79°C 175°F Orange-Brown
93°C 200°F Pink
107°C 225°F Dark Green
121°C 250°F Charcoal Grey
135°C 275°F White
149°C 300°F Red
163°C 325°F Yellow
177°C 350°F Brown
191°C 375°F Red & Green
204°C 400°F Purple & White
218°C 425°F Ivory
232°C 450°F Grey
246°C 475°F Tan
260°C 500°F Raspberry
288°C 550°F Light Green
316°C 600°F Terra-Cotta
371°C 700°F Orange
427°C 800°F Light Blue
OMEGA ENGINEERING, INC.
HOW TO USE
OMEGAPROBE

$20

The complete kit,
including the 20 crayons and holder in special case.

OMEGAPROBE™ Test Kits consist of 20 temperature indicating crayons and a special holder. The temperature range of the 20 crayons is from 125°F to 800°F (52°C to 427°C — see kit) and each crayon is accurate to within 1%.

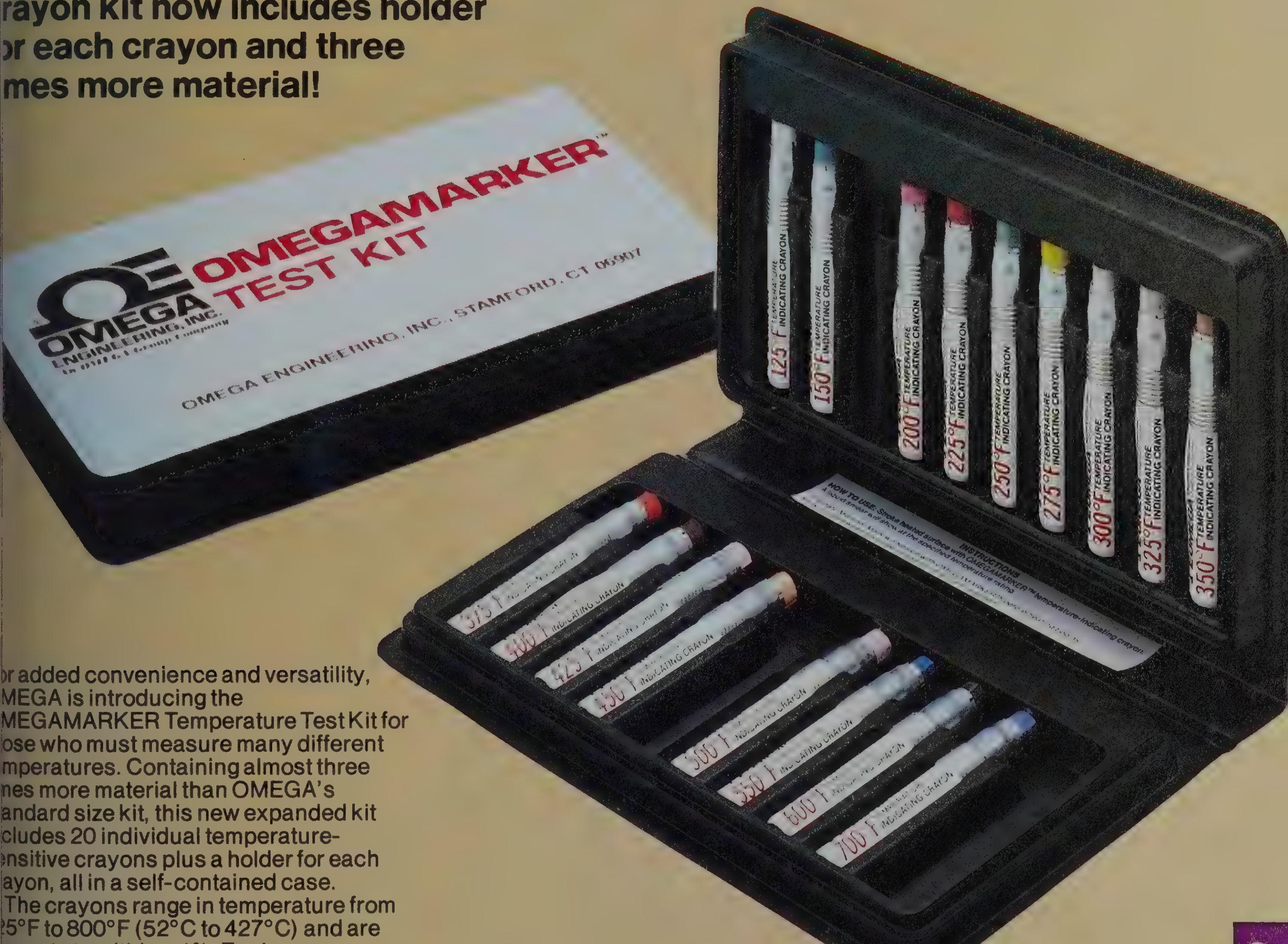
The surface to be heated is marked with the appropriate crayon insert. When the required temperature has been reached, the mark turns into a liquid smear. An alternate method for use is to periodically touch the workpiece with the crayon. If a chalk mark appears the rated temperature has not been reached.

When a liquid smear is left, the rated temperatur has been attained. None of the OMEGAPROBE crayons contain harmful toxic materials.

OMEGAPROBE™ Test Kits are ideal for lab use, also in welding, forging, heat-treating and fabrication of metals; molding of rubber and plastics; and generally for applications where the workpiece is accessible.

OMEGAMARKER™ Temperature Test Kit

xpanded temperature-sensitive rayon kit now includes holder or each crayon and three mes more material!

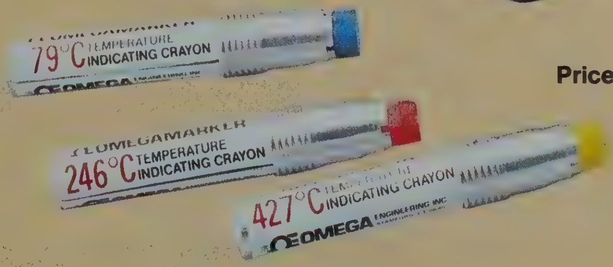

OMEGAMARKER™
OMEGA TEST KIT
OMEGA ENGINEERING, INC.
OMEGA ENGINEERING, INC., STAMFORD, CT 06907
125°F TEMPERATURE INDICATING CRAYON
150°F TEMPERATURE INDICATING CRAYON
200°F TEMPERATURE INDICATING CRAYON
225°F TEMPERATURE INDICATING CRAYON
250°F TEMPERATURE INDICATING CRAYON
275°F TEMPERATURE INDICATING CRAYON
300°F TEMPERATURE INDICATING CRAYON
325°F TEMPERATURE INDICATING CRAYON
350°F TEMPERATURE INDICATING CRAYON
INSTRUCTIONS
HOW TO USE: Stroke heated surface with OMEGAMARKER™ temperature-indicating crayon.
375°F
400°F INDICATING CRAYON
425°F INDICATING CRAYON
450°F INDICATING CRAYON
500°F INDICATING CRAYON
550°F INDICATING CRAYON
600°F INDICATING CRAYON
700°F INDICATING CRAYON

or added convenience and versatility, MEGA is introducing the MEGAMARKER Temperature Test Kit for ose who must measure many different mperatures. Containing almost three nes more material than OMEGA's andard size kit, this new expanded kit cludes 20 individual temperature-ensitive crayons plus a holder for each ayon, all in a self-contained case.

The crayons range in temperature from 5°F to 800°F (52°C to 427°C) and are ccurate to within ±1%. Each crayon easures 2½ inches long.

The OMEGAMARKER crayon is easy use — simply mark the surface to be eated with the appropriate crayon. When e desired temperature has been reached, e mark will liquefy. The crayons are itable for testing most surfaces — rough nd smooth.

Typical applications include lab use, rging, heat treating and fabrication of etals; molding of rubber and plastics; and r general-purpose use on any accessible eated surface.


79°C TEMPERATURE INDICATING CRAYON
OMEGAMARKER
246°C TEMPERATURE INDICATING CRAYON
427°C TEMPERATURE INDICATING CRAYON
OMEGA ENGINEERING INC

Price: **$68**

Includes 20 crayons and holders, plus case

Omega's Melting Point Standards.

AVAILABLE IN **Liquid** OR **Granular** FORM
±1°F ACCURACY TRACEABLE TO N.B.S.

- ✓ Calibrated to ±1°F accuracy on instruments with accuracies traceable to National Bureau of Standards.
- ✓ All materials are stable, low vapor pressure compounds proven in applications for more than 25 years.

MELTING POINT STANDARDS
Low Vapor Pressure Standards
Calibrated to ±1°F Accuracy
OMEGA ENGINEERING, INC.

Range	Number of Standards	Catalog Designation	Price
125°F-350°F (52°C-177°C) Granular	10	MPS-L10G	$65 Per Kit
375°F-600°F (191°C-316°C) Granular	10	MPS-H10G	
125°F-350°F (52°C-177°C) Liquid	10	MPS-L10L	
375°F-600°F (191°C-316°C) Liquid	10	MPS-H10L	
125°F-600°F (52°C-316°C) Granular	20	MPS-F20G	$130 Per Kit
125°F-600°F (52°C-316°C) Liquid	20	MPS-F20L	

Omega's Melting Point Standards

for calibrating hot stage and gradient bar melting point apparatus are also used in many quality control and analytical applications where accurate determination of surface temperature is required.

Standards are supplied in nominal 25°F spaced temperature increments. Each standard is further calibrated to a specific temperature near the nominal (rated) temperature to an accuracy of ±1°F.

Each ½ oz. jar is labeled with nominal rating and the actual calibration in degrees F and degrees C.

Thinners are available for Standards supplied in liquid form at $2.75 per 2 oz. bottle

*When ordering thinner, specify whether it is for use with Standards at or above 200 F

Also Available individually @ **$7.50** per ½ oz. jar.

Liquid Form*		**Granular Form**	
Nominal Temperature	**Catalog Designation**	**Nominal Temperature**	**Catalog Designation**
125°F (52°C)	MPS-125L	125°F (52°C)	MPS-125G
150°F (66°C)	MPS-150L	150°F (66°C)	MPS-150G
175°F (79°C)	MPS-175L	175°F (79°C)	MPS-175G
200°F (93°C)	MPS-200L	200°F (93°C)	MPS-200G
225°F (107°C)	MPS-225L	225°F (107°C)	MPS-225G
250°F (121°C)	MPS-250L	250°F (121°C)	MPS-250G
275°F (135°C)	MPS-275L	275°F (135°C)	MPS-275G
300°F (149°C)	MPS-300L	300°F (149°C)	MPS-300G
325°F (163°C)	MPS-325L	325°F (163°C)	MPS-325G
350°F (177°C)	MPS-350L	350°F (177°C)	MPS-350G
375°F (191°C)	MPS-375L	375°F (191°C)	MPS-375G
400°F (204°C)	MPS-400L	400°F (204°C)	MPS-400G
425°F (218°C)	MPS-425L	425°F (218°C)	MPS-425G
450°F (232°C)	MPS-450L	450°F (232°C)	MPS-450G
475°F (246°C)	MPS-475L	475°F (246°C)	MPS-475G
500°F (260°C)	MPS-500L	500°F (260°C)	MPS-500G
525°F (274°C)	MPS-525L	525°F (274°C)	MPS-525G
550°F (288°C)	MPS-550L	550°F (288°C)	MPS-550G
575°F (302°C)	MPS-575L	575°F (302°C)	MPS-575G
600°F (316°C)	MPS-600L	600°F (316°C)	MPS-600G

*Thinner available (2 oz. jar) @ $2.75 each. When ordering, specify thinner in **"Blue Label"** jar for use with temperature Standards up to and including 175°F. Use **"Red Label"** thinner with Standards at or above 200°F.

Available exclusively from Omega Engineering

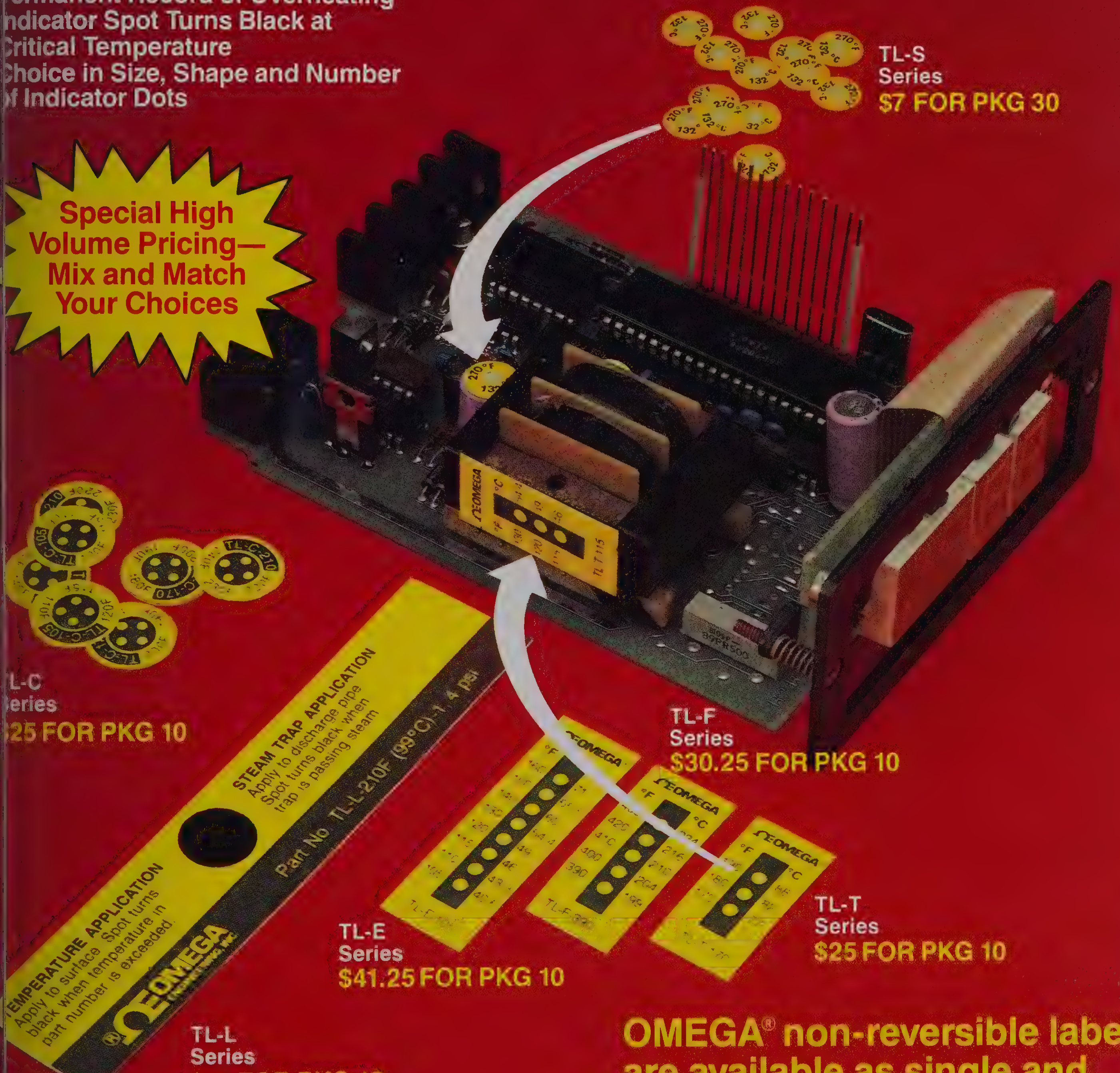
EMPERATURE LABELS

ON-REVERSIBLE TEMPERATURE INDICATORS

for permanent temperature monitoring

- elf-Adhesive Backing
- ermanent Record of Overheating
- ndicator Spot Turns Black at ritical Temperature
- hoice in Size, Shape and Number f Indicator Dots

Special High Volume Pricing— Mix and Match Your Choices


270°F
132°C
STEAM TRAP APPLICATION
Apply to discharge pipe
Spot turns black when
trap is passing steam
Part No TL-L-210F (99°C)-1 4 psi
EMPERATURE APPLICATION
Apply to surface Spot turns
black when temperature in
part number is exceeded
OMEGA

TL-S Series
$7 FOR PKG 30

L-C eries
25 FOR PKG 10

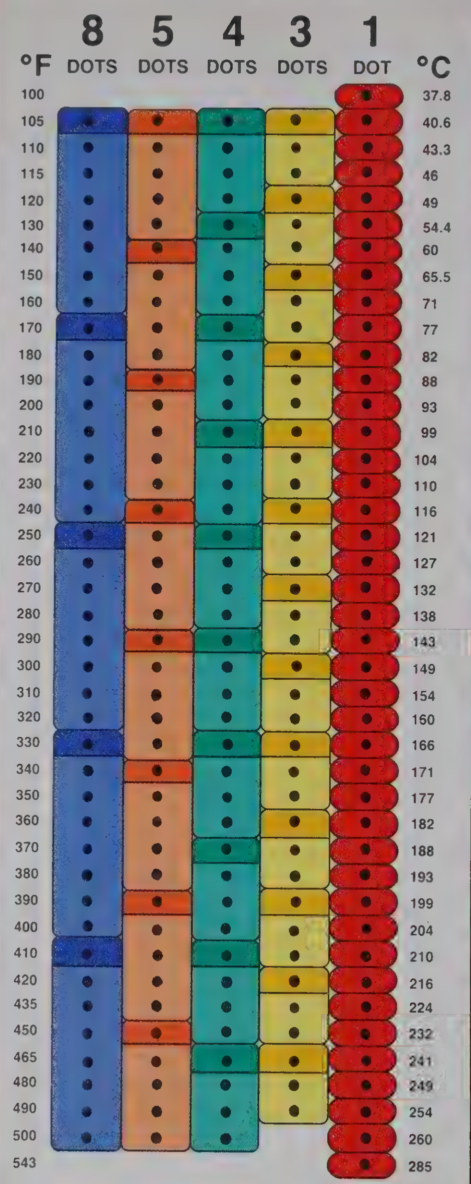
TL-F Series
$30.25 FOR PKG 10

TL-E Series
$41.25 FOR PKG 10

TL-T Series
$25 FOR PKG 10

TL-L Series
$24 FOR PKG 10

OMEGA® non-reversible labels are available as single and multi-temperature labels in easy-to-use 10 packs.



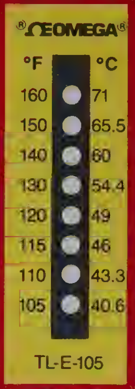
°F	8 DOTS	5 DOTS	4 DOTS	3 DOTS	1 DOT	°C
100					●	37.8
105	●	●	●	●	●	40.6
110	●	●	●	●	●	43.3
115	●	●	●	●	●	46
120	●	●	●	●	●	49
130	●	●	●	●	●	54.4
140	●	●	●	●	●	60
150	●	●	●	●	●	65.5
160	●	●	●	●	●	71
170	●	●	●	●	●	77
180	●	●	●	●	●	82
190	●	●	●	●	●	88
200	●	●	●	●	●	93
210	●	●	●	●	●	99
220	●	●	●	●	●	104
230	●	●	●	●	●	110
240	●	●	●	●	●	116
250	●	●	●	●	●	121
260	●	●	●	●	●	127
270	●	●	●	●	●	132
280	●	●	●	●	●	138
290	●	●	●	●	●	143
300	●	●	●	●	●	149
310	●	●	●	●	●	154
320	●	●	●	●	●	160
330	●	●	●	●	●	166
340	●	●	●	●	●	171
350	●	●	●	●	●	177
360	●	●	●	●	●	182
370	●	●	●	●	●	188
380	●	●	●	●	●	193
390	●	●	●	●	●	199
400	●	●	●	●	●	204
410	●	●	●	●	●	210
420	●	●	●	●	●	216
435	●	●	●	●	●	224
450	●	●	●	●	●	232
465	●	●	●	●	●	241
480	●	●	●	●	●	249
490	●	●	●	●	●	254
500	●	●	●		●	260
543					●	285

Part number includes lowest temperature on multiple spot label, e.g., TL-F-105 has dots for 105°F (40.6°C), 110°F (43.3°C), 115°F (46.0°C), 120°F (49.0°C), and 130°F (54.4°C).

TEMPERATURE LABELS

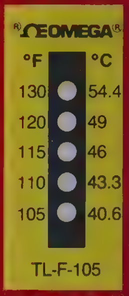
Straight Line Design labels are provided with 8, 5, and 3 dots. The three series are TL-E, TL-F, and TL-T respectively. Choose the labels that will bracket your critical temperature.

8 Dots



TL-E

5 Dots



TL-F

3 D

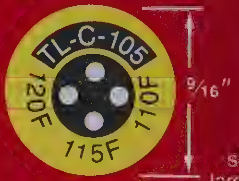
°F
110
105
100
TL-

TI

Shown Full Size

Round Design labels are available with cluster of 4 dots or with 1 dot. The two round series are TL-C and TL-S, respectively. TL-C is 9/16″ in diameter, and TL-S is 3/8″ in diameter. Select these labels where space is limited.

4 Dots

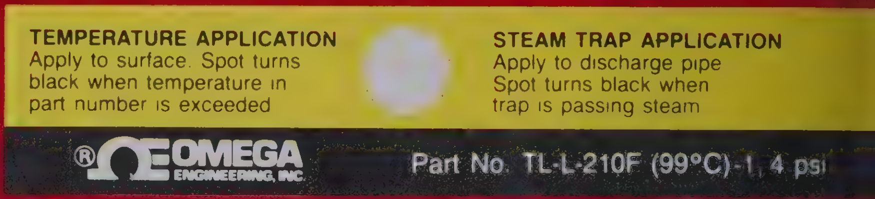


TL-C

shown larger than actual size

1 Dot

TL-S



TEMPERATURE APPLICATION
Apply to surface. Spot turns black when temperature in part number is exceeded

STEAM TRAP APPLICATION
Apply to discharge pipe
Spot turns black when trap is passing steam

Part No. TL-L-210F (99°C)-1, 4 psi

1 Big Spot on a Long Label is provided by our TL-L Series. Choose these labels to spot leaking steam traps, hot power lines, or where a highly visible label is needed.

How to Order

1. **Select label type and temperature range.**
2. **Use lowest temperature in part number.**

TL-[*]-[lowest temp.]
*** = E, F, T, C, S, or L**

Example: TL-E-105
is an 8 dot label covering
105° to 160°F

Series	Net Price
TL-E	**$41.25/10 pack**
TL-F	**30.25/10 pack**
TL-T	**25.00/10 pack**
TL-S	**7.00/30 pack**
TL-C	**25.00/10 pack**
TL-L	**24.00/10 pack**

Mix and Match Disco

Order Value	Disc
below $100	N
$100 to 200	10
$200.25 to 300	20
$300.25 to 400	30
$400.25 to 500	40
over $500.00	**Con**
Sales Departmen	

FEATURES

- **Dot Becomes Black at Rated Temperature**
- **Provides Permanent Record of Surface Temperature**
- **Self Adhesive**
- **Low Cost**
- **Easy-to-use**
- **Requires No Power, Batteries**
- **Clear, Visible Indication**

APPLICATIONS

- **Detects Overheated Bearings**
- **Finds Leaky Steam Traps**
- **Shows Hot Power Lines**
- **Resists Oil, Water, and Steam**
- **Suitable for Remote Locations**
- **Effective for Long Term Monitoring**
- **Ideal Sales Feature for Equipment Supplier**

Call Sales Department for Labels With Your Name and Logo or Other Special Markings

NEW!

Temperature Indicators

Reversible

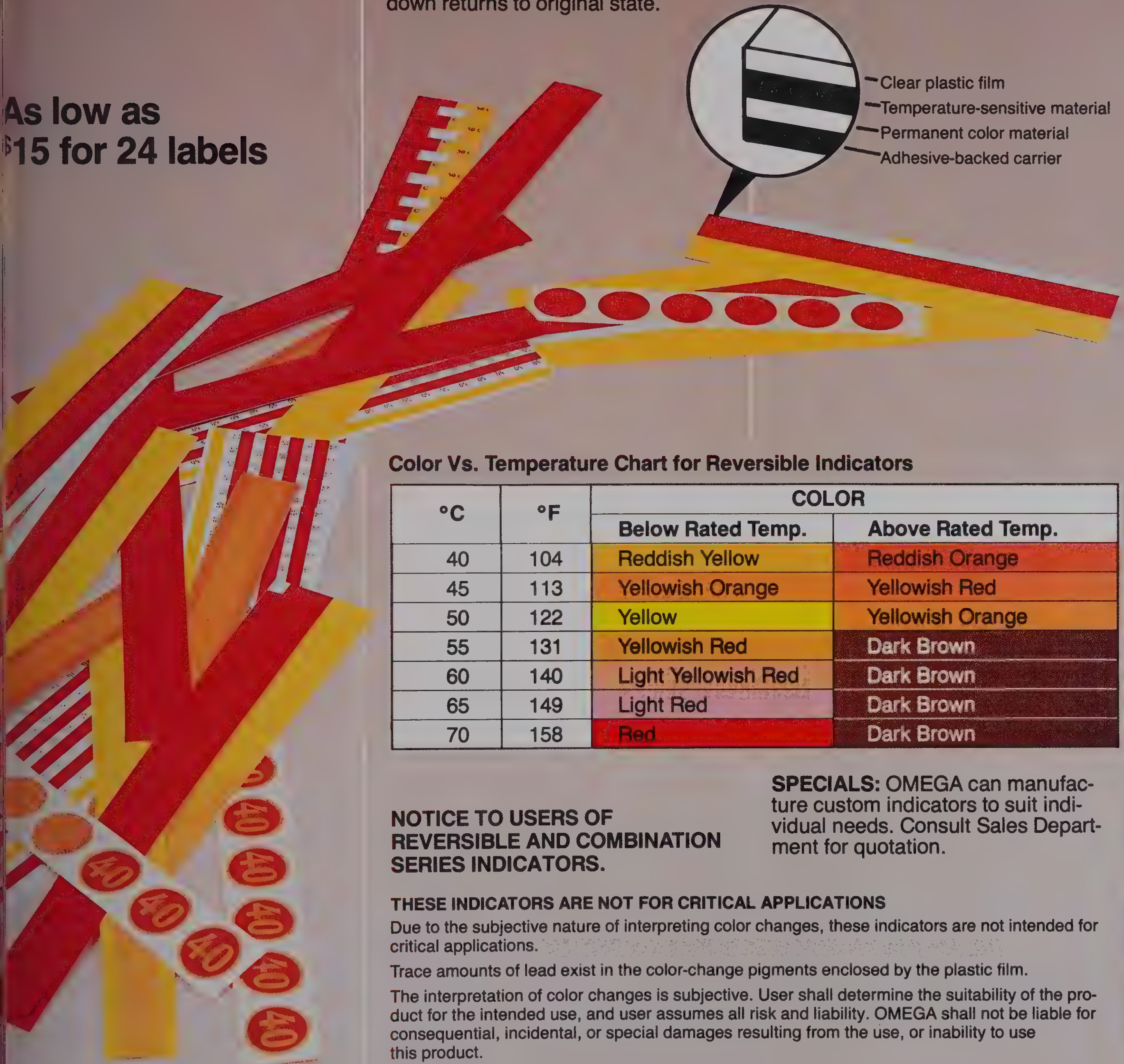
eversible Labels

eversible series indicators provide he user with a color indication of the emperature state of the object to hich the label is affixed. These elf-adhesive indicators are designd for heating applications and will eturn to their original color state pon cool-down.

As low as
15 for 24 labels

General Specifications

Operation: Indicator will change color upon heating. Change in hue will begin approximately 5°C below rated temperature and culminate in full signal color indication at rated temperature.
Accuracy: ±2°C (±3.5°F) (temperature rise)
Storage Temperature: 5° to 35°C (41° to 95°F)
Minimum Custom Label Size: 0.12″ × 0.12″ (3 mm × 3 mm)
Maximum Custom Label Size: 9.2″ × 9.2″ (230 mm × 230 mm)
Environment: Not affected by sunlight
Application: Heating (rated accuracy during temperature rise only). After cool-down returns to original state.



Color Vs. Temperature Chart for Reversible Indicators

°C	°F	COLOR	
		Below Rated Temp.	Above Rated Temp.
40	104	Reddish Yellow	Reddish Orange
45	113	Yellowish Orange	Yellowish Red
50	122	Yellow	Yellowish Orange
55	131	Yellowish Red	Dark Brown
60	140	Light Yellowish Red	Dark Brown
65	149	Light Red	Dark Brown
70	158	Red	Dark Brown

SPECIALS: OMEGA can manufacture custom indicators to suit individual needs. Consult Sales Department for quotation.

NOTICE TO USERS OF REVERSIBLE AND COMBINATION SERIES INDICATORS.

THESE INDICATORS ARE NOT FOR CRITICAL APPLICATIONS

Due to the subjective nature of interpreting color changes, these indicators are not intended for critical applications.

Trace amounts of lead exist in the color-change pigments enclosed by the plastic film.

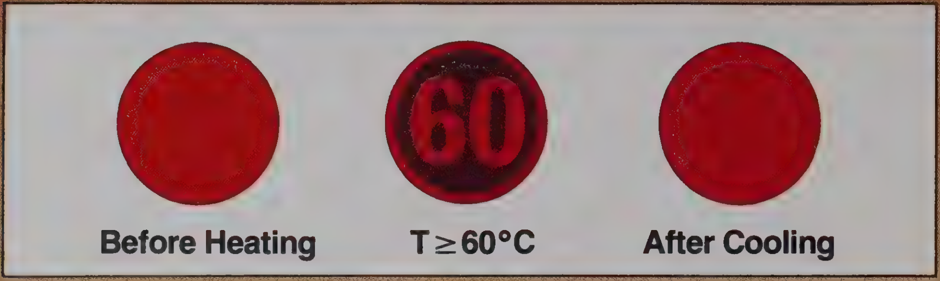
The interpretation of color changes is subjective. User shall determine the suitability of the product for the intended use, and user assumes all risk and liability. OMEGA shall not be liable for consequential, incidental, or special damages resulting from the use, or inability to use this product.

This product should not be used in the food industry.

Temperature Indicators

Reversible

Round Numeric

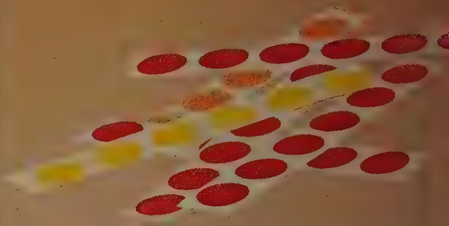


A round label with a centered degrees Celsius temperature rating. No color interpretation required—numeral is revealed upon heating. Available from 40° to 70°C (104° to 158°F) in five degree Celsius increments.

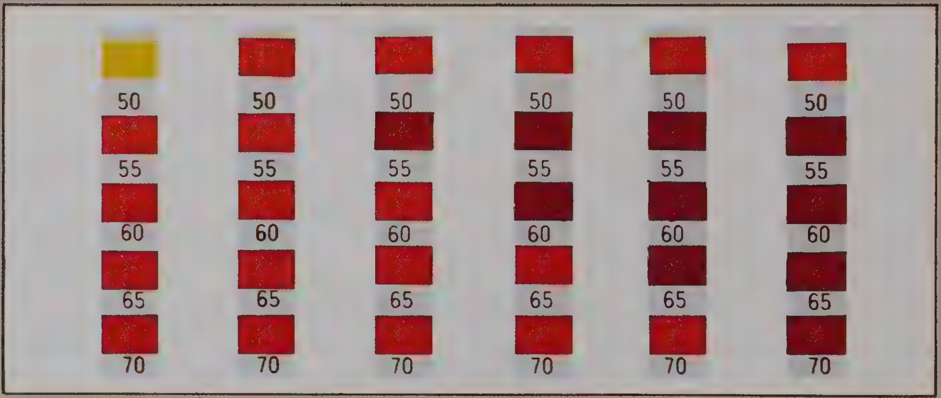
Accuracy: ±2°C (±3.5°F)
Size: 0.72″ diameter (18 mm diameter)
Package Size: 6 indicators/sheet; 4 sheets/pack
Catalog Number:
RRN-[ ]... Temperatures: 40, 45, 50, 55, 60, 65, 70°C

Price:

$15 pack
(24 labels)



5-Point



Each indicator contains five color temperature bands rated from 50° to 70° C (122 to 158°F) stepping in 5-degree Celsius increments. This provides the user with a profile of temperatures over a 20-degree Celsius range. Beneath each band the color transition temperature in degrees Celsius is printed.

Accuracy: ±2°C (±3.5°F)
Size: 0.28″ × 1.72″ (7 mm × 43 mm)
Package Size: Five color bands per indicator, 20 indicators/pack
Catalog Number: R5

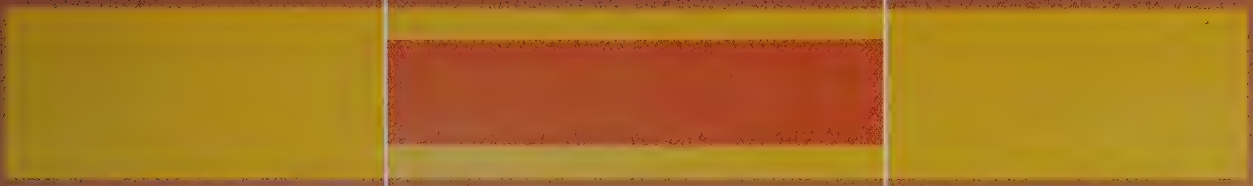
Price:

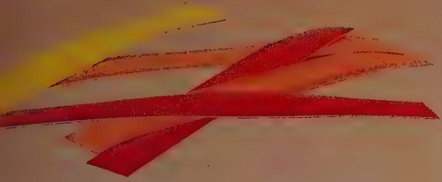
$25 pack

Temperature Indicators

Reversible

Tape


This section, below rated temperature.
This section, above rated temperature.
This section, below rated temperature.



Accuracy: ±2°C (±3.5°F)
Size: 0.8″ × 6.4″ (20 mm × 160 mm)
Package Size: 5 tapes/pack
Catalog Number:
RT-[ ]---Temperatures: 40, 50, 60, 70°C.

Price:

$15 pack

A band of color-sensitive material is displayed against a like-colored (before heating) background. Upon heating, the band displays contrasting color. Unambiguous change upon heating. Purchase the round numeric indicators with the tape to facilitate easy field interpretation of absolute temperature or use the color chart to relate color to temperature.

Twin Tape

This section T<50°C.
This section 50°C≤T<70°C.
This section T≥70°C.

Accuracy: ±2°C (±3.5°F)
Size: Each twin tape 1.2″ × 6.0″ (30 × 150 mm)
Package Size: 5 tapes/pack
Catalog Number: RTT-50-70

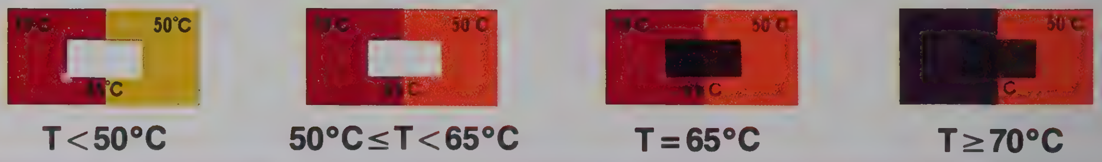
Price:

$17^{50} pack

Two contrasting color-sensitive bands rated at 50°C (122°F) and 70°C (158°F) are contained on one tape. The user obtains a profile of temperature over a 20-degree Celsius range and can tell at a glance whether the temperature is less than 50°C (122°F) within the 50° to 70°C (122° to 158°F) degree range, or over 70°C (158°F). Use temperature chart to relate color change to absolute temperature.

Temperature Indicators

Combination Irreversible/Reversible



A round, irreversible label rated at 65°C (149°F) is center-mounted over a pair of reversible contrasting color-sensitive bands rated at 50°C (122°F) and 70°C (158°F). The irreversible label changes unambiguously from white to black at 65°C (149°F) and provides the user with a permanent temperature record. The reversible part of the indicator provides the user with a profile of the temperature over a 20-degree Celsius range. One can tell at a glance whether the temperature is less than 50°C (122°F) within the 50° to 70°C range, or over 70°C (158°F). The reversible part of the indicator will return to its original state upon cooling and may be re-used. Use the chart to relate color to absolute temperature.

Description: Rectangular Irreversible Label Affixed to Reversible Rectangular Background. Temperatures Printed on Background.

Accuracy: ±2°C (±3.5°F)
Size: 0.6″ × 1.2″ (15 mm × 30 mm
Package Size: 8 indicators/pack
Catalog Number: I65-RTT
Price:

$24/pack

Temperature Indicator Kits

Reversible Temperature Indicator Kit

Catalog Number: RTK

A sampler kit containing many of the most popular reversible and combination series indicators.

Contents of RTK Kit:

Reversible Round Numeric:
Six reversible round indicators of each temperature 40°C (104°F) to 70°C (158°F) in 5-degree Celsius increments.

Total of 42 indicators—(Catalog No. RRN-[ ]- – 40°C to 70°C)

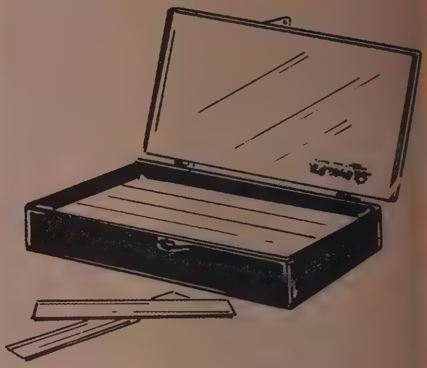
Reversible 5-Point:
Five reversible 5-point indicators. Each indicator has 5 temperature color bands rated 50° to 70°C (Catalog No. R5)

Reversible Tape:
One Reversible Tape in each temperature 40°C (104°F) to 70°C (158°F) in 10-degree Celsius increments.

Total of 4 tapes—(Catalog No. RT-[ ]---40° to 70°C)

Reversible Twin Tape:
One Twin Tape Indicator—(Catalog No. RTT 50/70)

Combination Irreversible/Reversible Indicator: Two combination indicators—(Catalog No. I65-RTT)



$49 RTK Kit

Deluxe Temperature Indicator Kit

Catalog Number: DTK

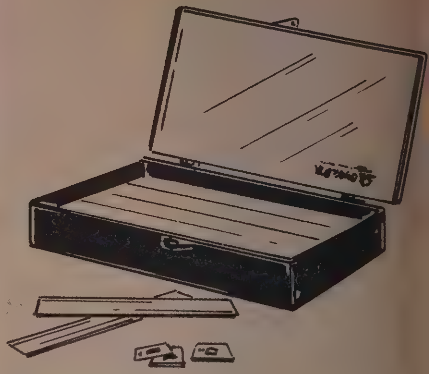
Contains all of the reversible indicators in the RTK kit and selected irreversible OMEGALABEL™ series labels. The labels cover the range from 100 to 170°F (38° to 77°C). Each irreversible label measures 1¾″ × 7/8″ and contains four temperature ratings. There are ten labels per box. The irreversible OMEGALABEL™ changes unambiguously from white to black at the rated temperatures printed on each label.

Contents of DTK Kit:

All of RTK Kit **plus** one box each of:

Catalog No. 4A-100 Temps: 100, 110, 120, 130°F on each label, ten labels/box

Catalog No. 4A-140 Temps: 140, 150, 160, 170°F on each label, ten labels/box



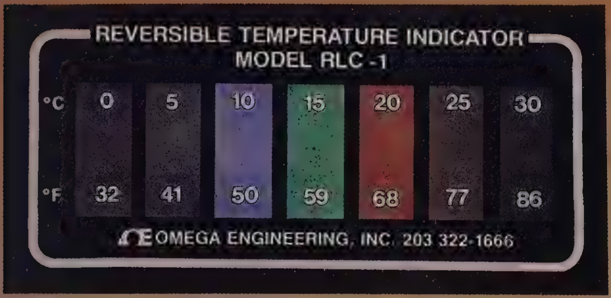
$79 DTK Kit

NEW! Temperature Indicators

Numeric Liquid Crystal Reversible

- Self-adhesive
- Clear, Easy-to-Read in °C and °F
- May Be Used for Both Heating and Cooling Applications
- Returns to Original State—May Be Used Over and Over
- Safe, Non-toxic Encapsulated Compounds
- Temperature Range: 0° to 60°C (32° to 140°F)
- Electrically Non-conductive

INTERPRETING LIQUID CRYSTAL LABELS

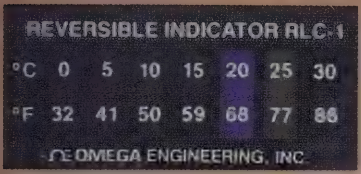

REVERSIBLE TEMPERATURE INDICATOR
MODEL RLC-1
°C 0 5 10 15 20 25 30
°F 32 41 50 59 68 77 86
OMEGA ENGINEERING, INC. 203 322-1666

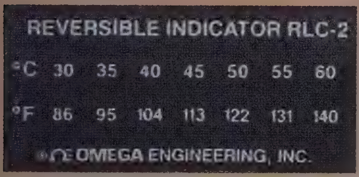
Actual Temperature is slightly above BLUE highlighted numerals.

GREEN indicates Actual Temperature.

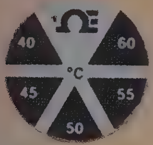
Actual Temperature is slightly below BROWN highlighted numeral.

Shown Actual Size


REVERSIBLE INDICATOR RLC-1
°C 0 5 10 15 20 25 30
°F 32 41 50 59 68 77 86
OMEGA ENGINEERING, INC.


REVERSIBLE INDICATOR RLC-2
°C 30 35 40 45 50 55 60
°F 86 95 104 113 122 131 140
OMEGA ENGINEERING, INC.

45 50 55 60
°C OMEGA®


40
60
°C
45
55
50

$32.50/10 pack

How to order

Catalog No.: **RLC-1**
Range: 0° to 30°C (32° to 86°F)
Size: 7/8″ × 1 7/8″ (22 × 47.6 mm)
Price: **$32.50**/10 pack

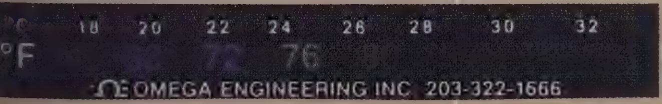
Catalog No.: **RLC-2**
Range: 30° to 60°C (86° to 140°F)
Size: 7/8″ × 1 7/8″ (22 × 47.6 mm)
Price: **$32.50**/10 pack

Catalog No.: **RLC-10 [ ]—°C or °F**
Range: 45° to 60°C (113° to 140°F)
Size: ⅜″ × 1″ (9.5 mm × 25.4 mm)
Price: **$32.50**/10 pack

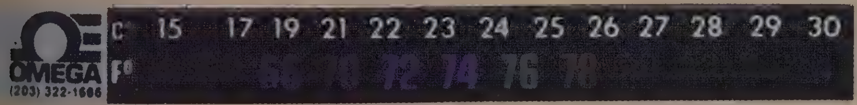
Catalog No.: **RLC-20 [ ]—°C or °F**
Range: 40° to 60°C (104° to 140°F)
Size: ¾″ Diameter (19 mm)
Price: **$32.50**/10 pack

STRIP THERMOMETERS

Shown Actual Size


°C 18 20 22 24 26 28 30 32
°F 72 76
OMEGA ENGINEERING INC 203-322-1666

- Catalog No. RLC-30 **$30.50/pack of 10**


OMEGA
(203) 322-1666
C 15 17 19 21 22 23 24 25 26 27 28 29 30
F° 66 70 72 74 76 78

- Adhesive Backed. Catalog No. RLC-40 **$32.50/pack of 10**
- Magnetic Backed. Catalog No. RLC-40-M **$35.00/pack of 10**

Specials:

What is your application? OMEGA can manufacture to suit your needs. Customized thermometers are available for promotions and resale. Consult our Sales Department.

Applications:

Ideal for monitoring temperatures of electronic parts, transformers, relays, and motors. Provides users of tools and machinery a fast visual indication of temperature while working. These labels may also be used in testing and quality control.

Specifications:

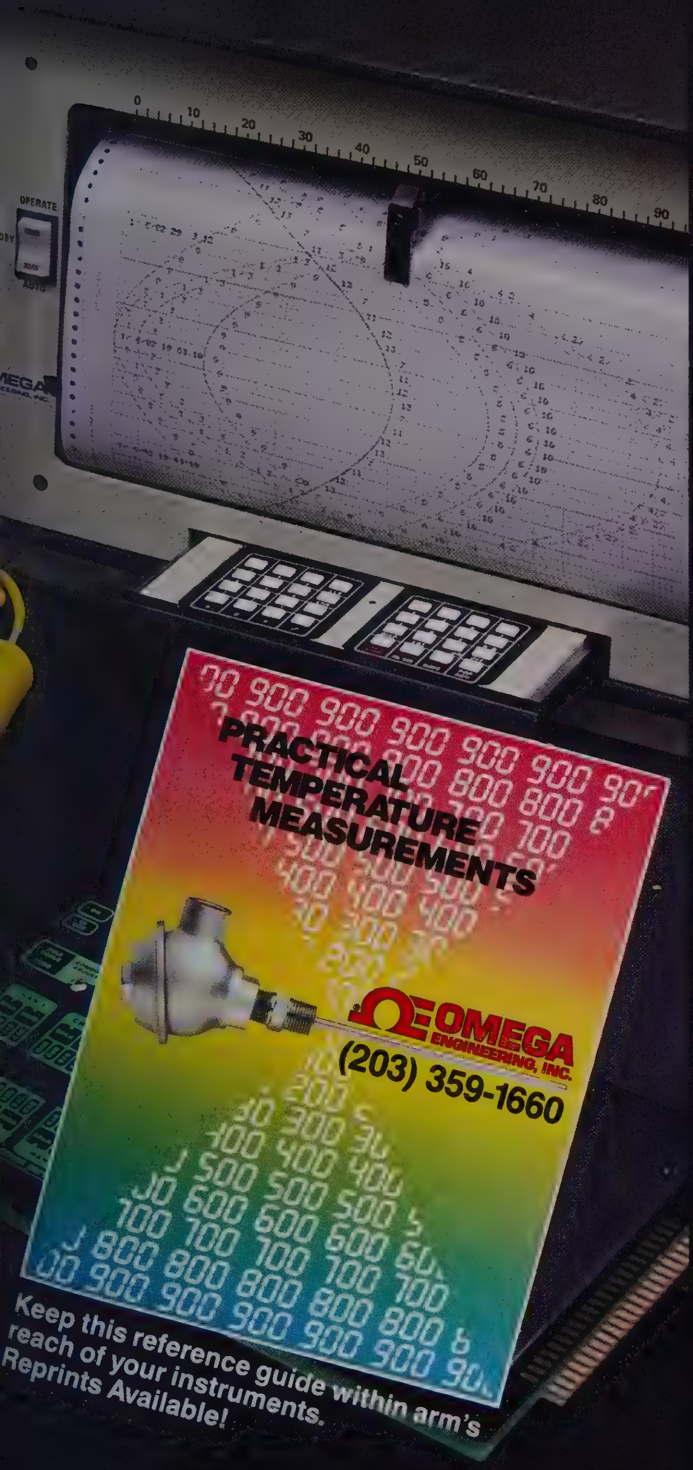
Construction and Operation—Encapsulated liquid crystal material is sandwiched between an adhesive backdrop and an upper Mylar film. Liquid crystals selectively reflect different colors depending upon their temperature.

Response Time: Fast! (½ to 2 seconds typical)
Thickness: Approx. 0.010″
Accuracy: ±1°F
Environment: Recommended storage: 10°C to 38°C (50°F to 100°F). Avoid prolonged exposure to sunlight and ultraviolet.

Discount Schedule:		
10 Packs	Price/ Label	Price/ 10 Pack
1-9	($3.25)	$32.50
10-49	($2.50)	25.00
50-99	($2.00)	20.00
100-Up	Special Quote	

NOTE: Sold only in packages of 10.

OMEGA ENGINEERING, INC.
STAMFORD, CONN.
OMEGA ENGINEERING, INC.
OM 205
14 072
ALARM LIMIT
TIME DAY
POINT ALARM ASSIGN
START TIME AUTO
POINT SKIP
PAPER FEED
POINT VALUE
START LOG
PROG
ENTER
μMEGA™
INTELLIGENT SCANNING SYSTEM
OMEGA ENGINEERING, INC.


PRACTICAL TEMPERATURE MEASUREMENTS
OMEGA ENGINEERING, INC.
(203) 359-1660

Keep this reference guide within arm's reach of your instruments.
Reprints Available!

R

Computer Interface and Data Acquisition

Glossary and Tutorial R-3, R-21, R-37
Modular Signal Conditioners and Alarms R-5
Thermocouple Reference Junction Conditioners R-15
Analog to ASCII Converter WB-31 R-18
Talking Communications Monitor SLCII R-23
μMEGA™ Intelligent Computer Interface R-27
Dual Thermometer Kits R-39
Multi Channel Scanner/Plotter R-43
Data Logger R-45
Computer Cables and Floppy Disks R-53
Solid State Switches and Relays R-55

Data Acquisition and Microcomputer Glossary

A glossary of terms related to data acquisition, control and microcomputers

A

ACCURACY—The deviation or error, by which an actual output varies from an expected ideal or absolute output. Each element in a measurement system contributes errors, which should be separately specified if they significantly contribute to the degradation of total system accuracy. See resolution.

ADDRESS—The label or number identifying the memory location where a unit of information is stored.

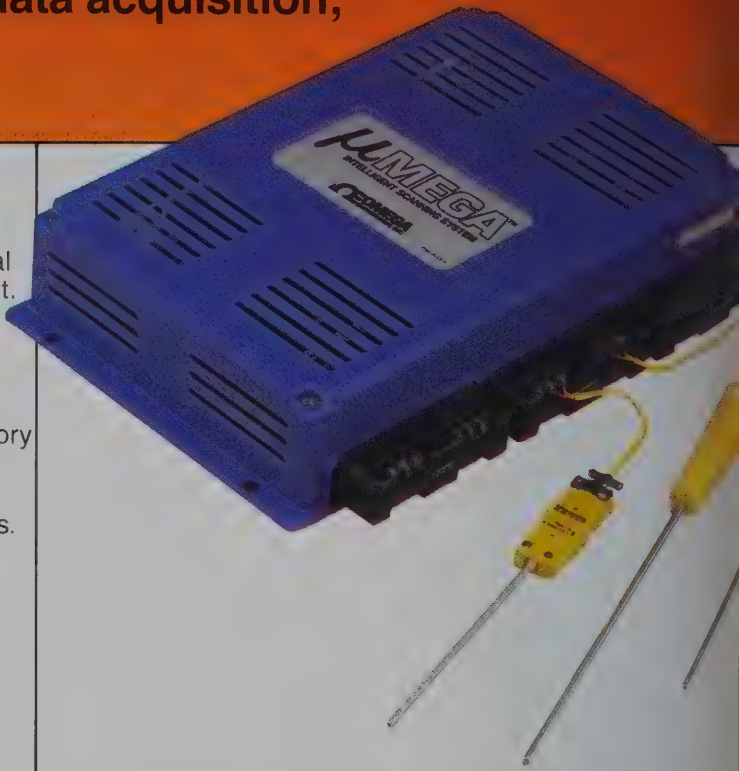
ALU—Arithmetic Logic Unit. The part of a CPU where binary data is acted upon with mathematical operations.

ANALOG-TO-DIGITAL CONVERTER (A/D, ADC)
A device or circuit that outputs a binary number corresponding to an analog voltage level at the input.

ASCII—Acronym for American Standard Code for Information Interchange. A seven-bit code used to represent alphanumeric characters. It is useful for such things as sending information between a computer and a peripheral, and from one computer to another.

ASSEMBLER—A program that translates assembly language instructions into machine language instructions.

ASSEMBLY LANGUAGE—A machine oriented language in which mnemonics are used to represent each machine language instruction. Each CPU has its own specific assembly language.



ASYNCHRONOUS—A communication method where data is sent when it is ready rather than waiting until the receiver signals that it is ready to receive.

B

BASIC—A high-level programming language designed at Dartmouth College as a learning tool called Beginner's All-purpose Symbolic Instruction Code.

BAUD—A unit of data transmission speed most usually simply meaning bits per second: 300 baud = 300 bits per second.

BINARY—Refers to the base-2 number system in which the only allowable digits are 0 and 1.

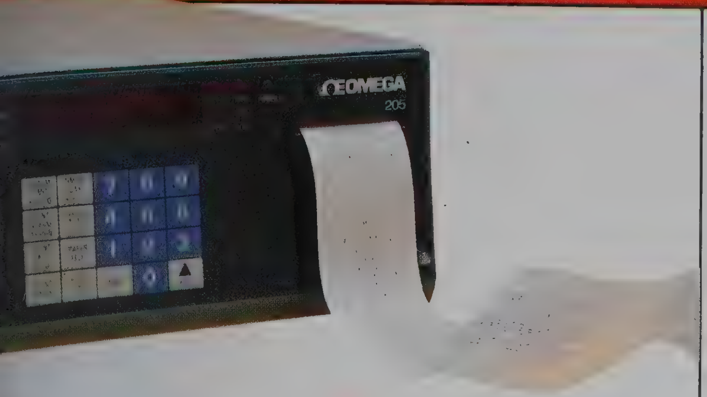
BINARY CODED DECIMAL (BCD)—The representation of a decimal number (0 through 9) by means of a 4 bit binary nibble.

BIT—Acronym for BInary digiT. The smallest unit of computer information, it is either a binary 0 or 1.

BUFFER—A temporary storage area for data when transmitted from one area to another to compensate for a speed difference.

BUS—Parallel lines used to transfer signals between devices or components. Computers are often described by their bus structure (i.e., S-100 bus computers, etc.)

BYTE—A group of eight bits.



C

CLOCK—The timing signal for a microprocessor.

CLEAR—To restore a device to a prescribed initial state, usually the zero state.

COMPILER—A program that translates a high-level language, such as BASIC, into machine language.

CRASH—A hardware or software fault that causes the computer to cease operating, usually requiring a clear or reset operation.

CPU—Acronym for Central Processing Unit. The part of the computer that contains the circuits that control and perform the execution of computer instructions.

D

DATA BASE—A large amount of data stored in a well-organized manner. A data-base management system is a program that allows access to the information.

DIGITAL-TO-ANALOG CONVERTER (D/A, DAC)—A device or circuit to convert a digital value to an analog voltage level.

DISK OPERATING SYSTEM—Program used to control the transfer of information to and from a disk. Often referred to as a DOS.

THERMOCOUPLE THERMOMETER
100 °C
MODEL 660
OMEGA
ENGINEERING, INC.

DOT-MATRIX PRINTER—A printer that forms characters from a two-dimensional array of dots. More dots in a given space produce characters that are more legible.

E

ELECTRONIC INDUSTRIES ASSOCIATION (EIA)—A standards organization specializing in the electrical and functional characteristics of interface equipment.

EPROM—A PROM that can be erased by the user, usually by exposing it to ultraviolet light. See PROM.

F

FORTRAN (Formula Translation)—A widely used high-level programming language well suited to problems that can be expressed in terms of algebraic formulas. It is generally used in scientific applications.

FULL-DUPLEX—Two way communication where both sides are transmitting and receiving at the same time.

FLOPPY DISK—A small, flexible disk carrying a magnetic medium in which digital data is stored for later retrieval and use.

FILE—A collection of data that is treated as a unit.

FIRMWARE—Programs stored in PROM or EPROM.

H

HALF-DUPLEX—One-Way-At-A-Time communication. Both sides can transmit data and receive data, but only one at a time.

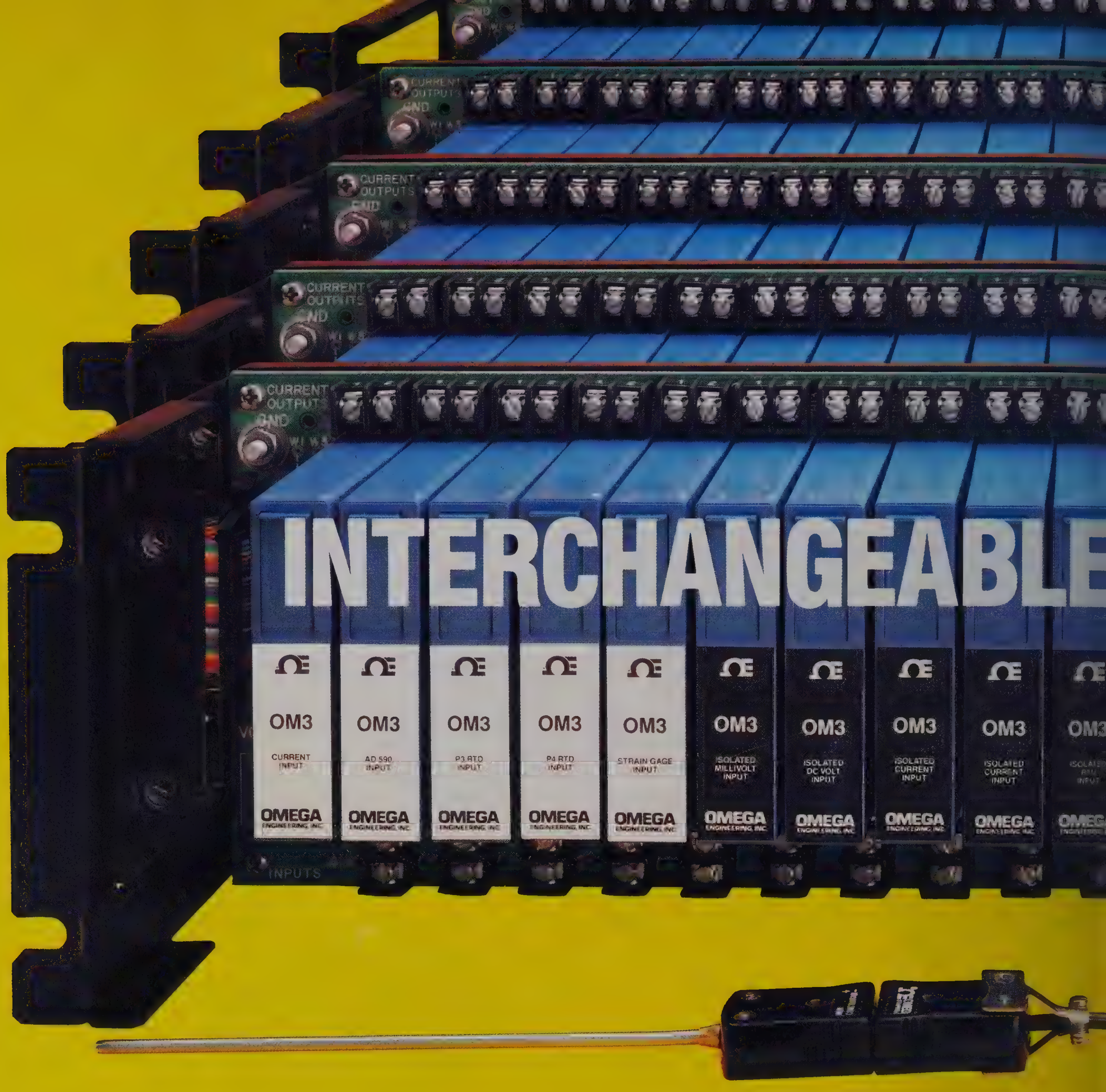
HANDSHAKE—An interface procedure that is based on status/data signals that assure orderly data transfer as opposed to asychronous exchange.

HARDCOPY—Output in a permanent form (usually on paper or paper tape) rather than in temporary form, as on CRT or visual display.

HARDWARE—The electrical, mechanical, and electromechanical equipment and parts associated with a computing system, as opposed to its firmware or software.

HEXADECIMAL—Refers to a base-sixteen number system using the characters 0 through 9 and the letters A through F to represent the values. Machine language programs are often written in hexadecimal notation.

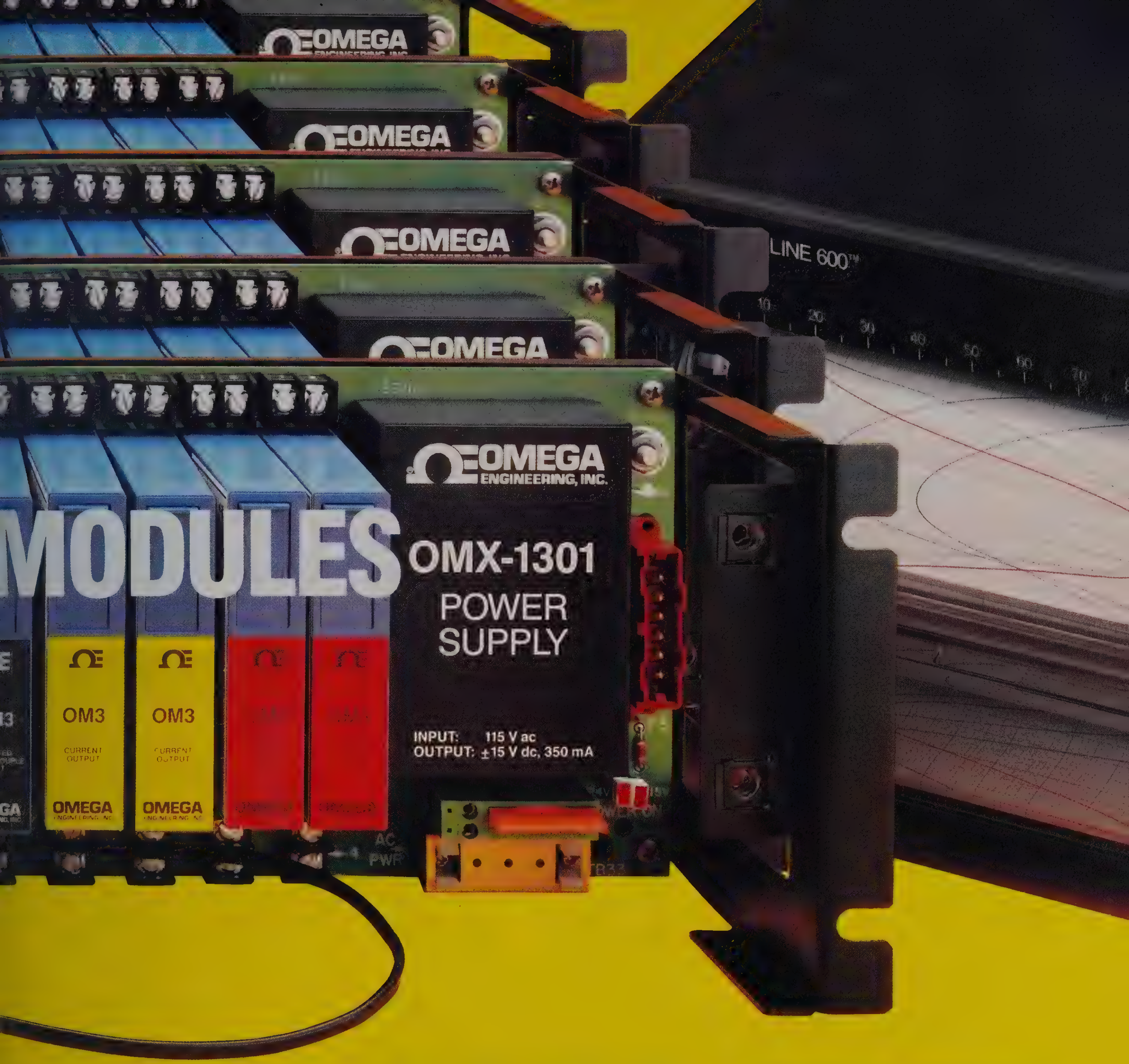
ACQUISITION AND MICROCOMPUTER GLOSSARY
(Continued on page R-37)


INTERCHANGEABLE
CURRENT OUTPUTS
GND
INPUTS
OM3
CURRENT INPUT
AD 590 INPUT
P3 RTD INPUT
P4 RTD INPUT
STRAIN GAGE INPUT
ISOLATED MILLIVOLT INPUT
ISOLATED DC VOLT INPUT
ISOLATED CURRENT INPUT
OMEGA ENGINEERING, INC.

OMEGA® BUILDS

The OM3 Series Signal Conditioners

- Condition
- Record
- Alarm
- Control


MODULES
OMEGA ENGINEERING, INC.
OMX-1301
POWER SUPPLY
INPUT: 115 V ac
OUTPUT: ±15 V dc, 350 mA
OM3
CURRENT OUTPUT
OMEGA ENGINEERING, INC.
LINE 600™
AC PWR

Gold-Plated Pin and Socket Connectors

Standard 19″ Rack Mounting

Any Mix of Input and Output Modules

Wide Choice of Power Options

5 Many Types of Sensor and Analog Signal Inputs

6 Thermocouple Cold Junction Compensation Provided on Each Channel

7 Screw Terminals for Direct Sensor Wiring

8 Simultaneous Voltage and Current Outputs

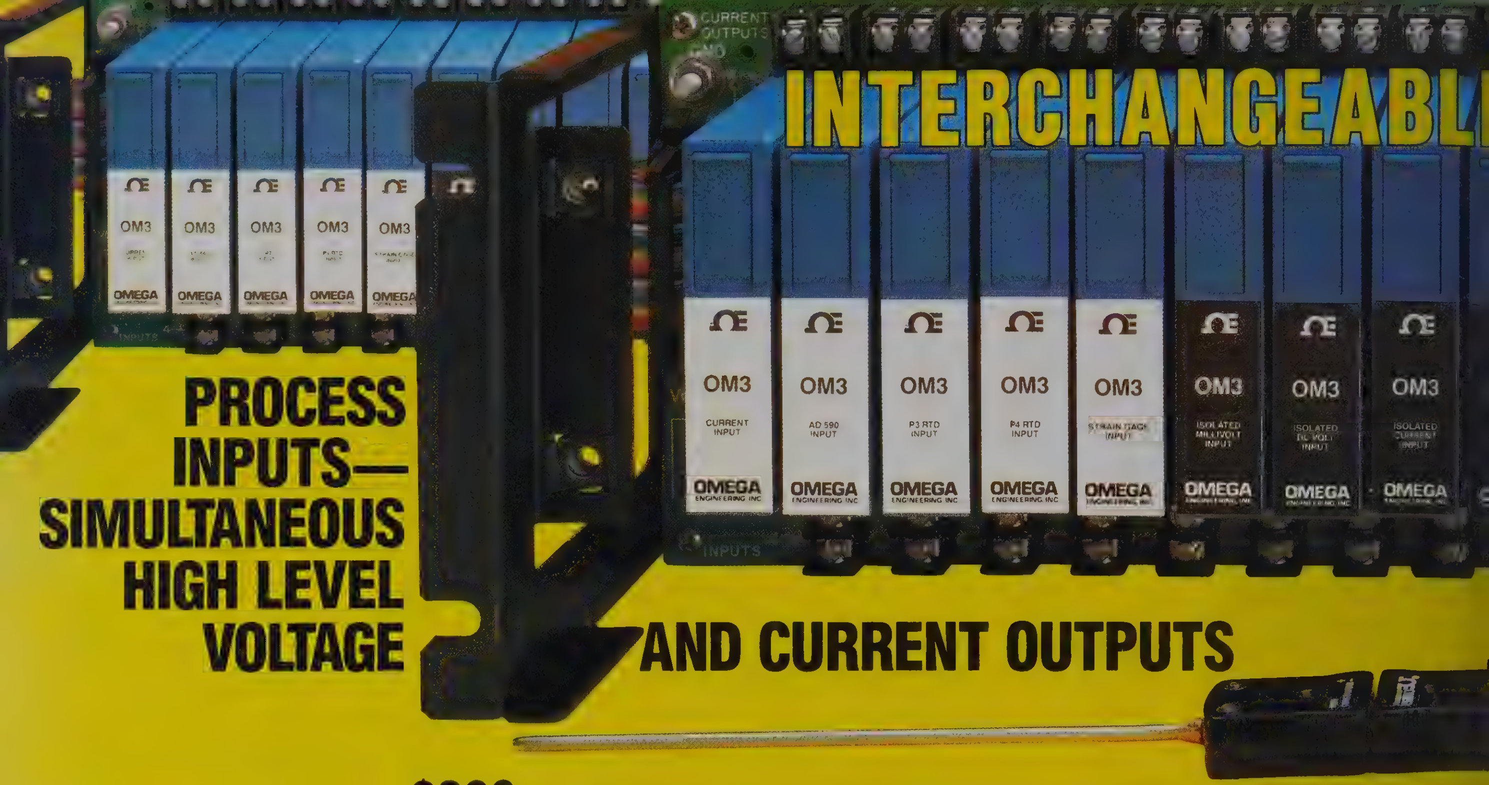
9 High Level Alarms

10 Ribbon Cable for High Level Voltage Outputs

11 Complete Signal Conditioning Function per Module

BETTER SIGNAL CONDITIONERS

11 WAYS

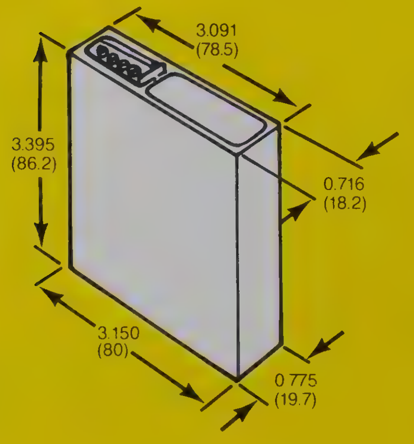


INTERCHANGEABL PROCESS INPUTS— SIMULTANEOUS HIGH LEVEL VOLTAGE AND CURRENT OUTPUTS

Thermocouple Input $200

Model No.	Range
OM3-ITC-J	J −100°C to + 760°C
OM3-ITC-K	K −100°C to +1350°C
OM3-ITC-T	T −100°C to + 400°C
OM3-ITC-E	E 0°C to + 900°C
OM3-ITC-R	R 0°C to +1750°C
OM3-ITC-S	S 0°C to +1750°C
OM3-ITC-B	B 0°C to +1800°C

The isolated thermocouple modules incorporate cold junction compensation circuitry which provides an accuracy of ±0.5°C over the +5°C to +45°C ambient temperature range. Open thermocouple detection (upscale) is also provided with the thermocouple modules. Standard modules are available with factory calibration for thermocouple types J, K, T, E, R, S, and B. However, if another thermocouple type or a special range is desired, consult our Applications Engineers for special ranges.



RTD Input

Nonisolated 2 or 3 Wire $160

Model No.	Range
OM3-P3-N100	−100°C to +100°C
OM3-P3-100	0°C to +100°C
OM3-P3-200	0°C to +200°C
OM3-P3-600	0°C to +600°C

Nonisolated 4 Wire $160

Model No.	Range
OM3-P4-N100	−100°C to +100°C
OM3-P4-100	0°C to +100°C
OM3-P4-200	0°C to +200°C
OM3-P4-600	0°C to +600°C

Isolated 2, 3 or 4 Wire $200

Model No.	Range
OM3-IP-N100	−100°C to +100°C
OM3-IP-100	0°C to +100°C
OM3-IP-200	0°C to +200°C
OM3-IP-600	0°C to +600°C

Each RTD module provides a sensor excitation current of 0.25 mA and produces an output signal that is linear with temperature with a conformity error of ±0.05% of span and accuracy of ±0.1% of span. The lead resistance effect is ±0.02%°C/Ω for the P3 and IP, and ±.00001°C/Ω for the P4.

The RTD modules are factory calibrated for sensors with an $\alpha = 0.00385$. A ±5% adjustment of both zero and span allows individual compensation for sensor errors on each channel or even recalibrate for different alphas.

GENERAL INPUT MODULE SPECIFICATIONS

Module
Inputs
Outputs[1, 2]
Accuracy[3]
Nonlinearity[4]
Common Mode Voltage, Input to Output
Common Mode Rejection @ 50 Hz or 60 Hz 1 kΩ Source Unbalance
Normal Mode Rejection @ 50 Hz or 60 Hz
Differential Input Protection
Voltage Output Protection
Current Output Protection
Zero and Span Adjustment Range
Input Resistance
Input Bias Current
Power Supply[5]
Size
Environmental Temperature Range, Rated Performance
Storage Temperature Range
Relative Humidity
RFI Susceptibility

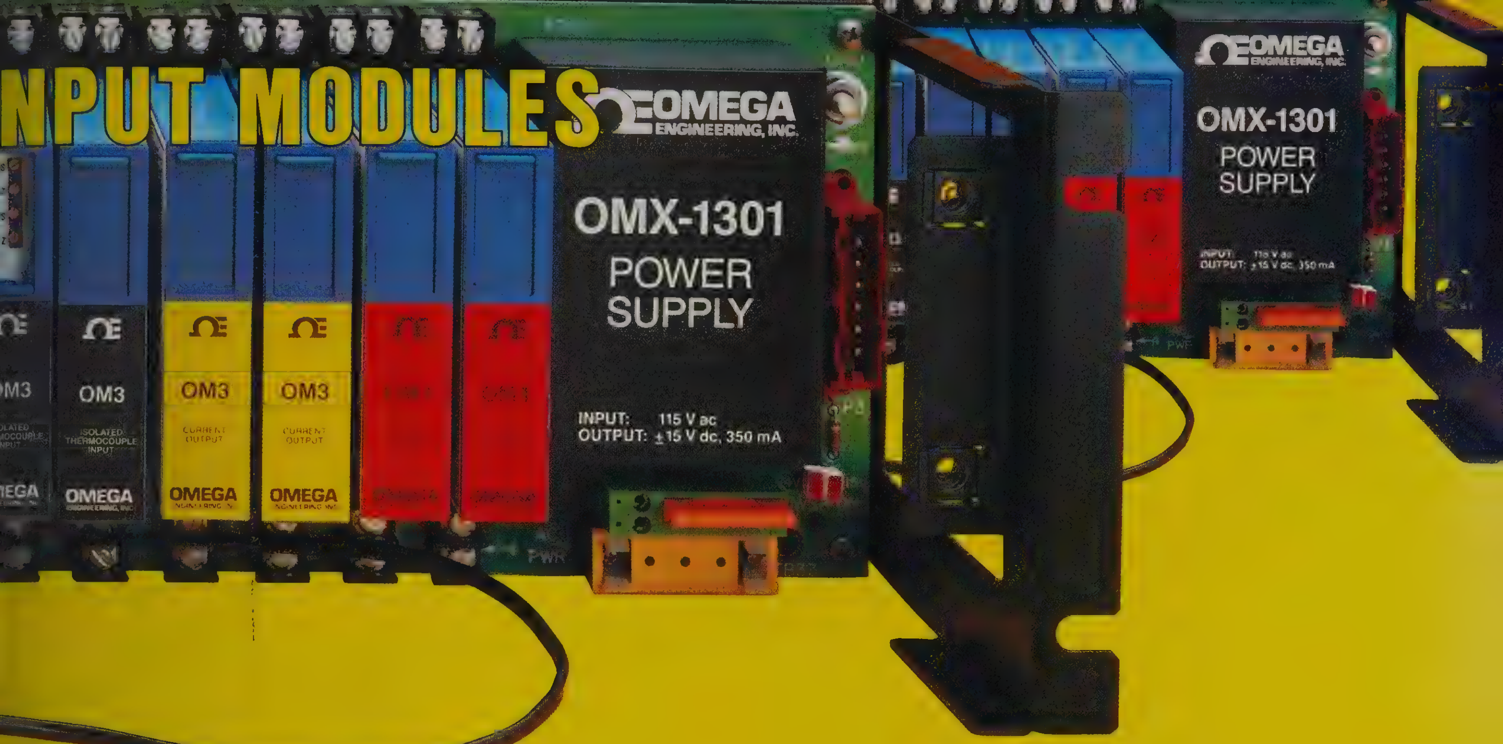
Notes

[1] Voltage output range is determined by the module input range while the current output range is user selectable.

[2] For a 0-20 mA range, a typical minimum output current is 10 μA.

[3] Accuracy spec includes the combined effec of repeatability, hysteresis and linearity. Does not include sensor or signal source error.

NPUT MODULES


OMEGA ENGINEERING, INC.
OMX-1301
POWER SUPPLY
INPUT: 115 V ac
OUTPUT: ±15 V dc, 350 mA
OMEGA ENGINEERING, INC.
OMX-1301
POWER SUPPLY
OM3
OM3
ISOLATED THERMOCOUPLE INPUT
OM3
CURRENT OUTPUT
OM3
CURRENT OUTPUT
OMEGA
OMEGA
OMEGA
OMEGA
PWR

typical @ +25°C and ±15 V, +24 V dc power)

olated odules	Nonisolated Modules
er Selection Table	*
to +10V @ 5 mA or ±10V @ 5 mA 4-20 mA or -20 mA R¹ = 0 to 850 Ω²	
0.1% span	*
0.01% span	*
1500 V pk max	±6.5 V
60 dB	90 dB
0 dB	60 dB
20 V rms	130V rms
ontinuous Short to Ground	*
30 V rms, cont.	*
5% of span	*
5 M Ω	100 M Ω
nA	*
15 V dc, +24 V dc	*
150″ × 0.775″ × 3.395″	*
25°C to +85°C	*
55°C to +85°C	*
to 95% @ 60°C oncondensing	*
0.5% span error, W @ 400 M Hz @ 3 ft.)	*

Except RTD ranges.

+24 V dc power is only needed for driving the urrent output at up to 850 Ω. If only voltage utput is used, or a current output load of 400 Ω r less is desired, ±15 V is all that is required.

Specifications same as isolated modules.

pecifications subject to change without otice.

Strain Gage Input

Model OM3-S-3 **$160**

The strain gage module provides a bridge excitation voltage of +10 V and can be used with a bridge resistance of 300 Ω or greater.

Millivolt and Voltage Input

Nonisolated Modules **$135**

Model No.	Range
OM3-mV-10	±10 mV
OM3-mV-50	±50 mV
OM3-mV-100	±100 mV
OM3-V-1	±1 V
OM3-V-5	±5 V
OM3-V-10	±10 V

Isolated Modules **mV $200**
V 175

Model No.	Range
OM3-ImV-10	±10 mV
OM3-ImV-50	±50 mV
OM3-ImV-100	±100 mV
OM3-IV-1	±1 V
OM3-IV-5	±5 V
OM3-IV-10	±10 V

Modules mV and V are nonisolated modules that accept millivolt and voltage signals respectively. Modules ImV and IV are isolated modules that accept millivolt and voltage signals respectively.

CURRENT INPUT

Nonisolated Modules **$135**

Model No.	Range
OM3-I-4/20	4-20 mA
OM3-I-0/20	0-20 mA

Isolated Modules **$175**

Model No.	Range
OM3-II-4/20	4-20 mA
OM3-II-0/20	0-20 mA

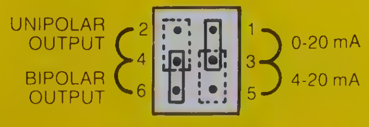
Modules I and II are nonisolated and isolated modules, respectively, that accept process current signals. Both modules use a 100 Ω sensing resistor that is mounted on backplane terminals 2 and 3.

AD 590 Input

OM3-A-590 −55°C to 130°C **$160**

Module A accepts an AD590 as its input signal. Sensor excitation is provided and a 2 k Ω sensing resistor is mounted on backplane terminals 2 and 3.

OUTPUT
JUMPER PROGRAMMING


UNIPOLAR OUTPUT
BIPOLAR OUTPUT
2
4
6
1
3
5
0-20 mA
4-20 mA

BOTTOM VIEW

COMPLETE YOUR INPUT/OUTPUT

- **High Level Voltage Input (0 to +10 V, ±10 V)**
- **Process Current Output (4-20 mA/0-20 mA)**
- **High Accuracy: ±0.1%**
- **Reliable Transformer Isolation**
- **Low Cost Per Channel**

Output Modules

Each output module accepts a high level analog signal and provides a current output. When a +24 V loop supply is used, loads up to 850 Ω can be driven. If desired, +15 V can be used to power the output modules with a smaller load (up to 400 Ω). Each output module features high accuracy of ±0.1%. If isolation is required, the IVI provides ±1500 V peak common mode voltage isolation protection.

Each output module has two user programmable jumper options. One option allows the user to program the current output to be proportional to either a 0 to +10 V input or a −10 V to +10 V input. The second option allows the user to set the current output span to 4-20 mA or 0-20 mA. All output modules are shipped from the factory so that the current output is proportional to the 0 to +10 V input and all current outputs are 4-20 mA.

General Output Module Specifications

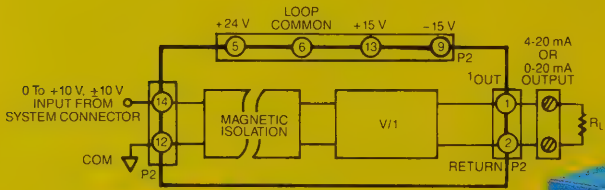
(Typical @ +25°C and ±15 V, +24 V dc)

Inputs	0 to + 10 V, ± 10 V
Outputs	4-20 mA or 0-20 mA
Accuracy	+0.1% span
Nonlinearity	±0.01%
Stability vs. Ambient Temperature	
Zero	±0.0025% span/°C
Span	±0.002% reading/°C
Common Mode Voltage, Output to Input and Power Supply	±1500 V pk max (Nonisolated N/A)
Common Mode Rejection	90 dB
Normal Mode Output Protection	220 V rms, Continuous (Nonisolated: 130 V rms)
Zero and Span Adjustment Range	±5% of span
Input Resistance	10 K Ω
Maximum Input Voltage Without Damage	±20 V
Temperature Range, Rated Performance	−25°C to +85°C

To Order:

Isolated
OM3-IVI **$120**

Nonisolated
OM3-VI **90**



OM3
ISOLATED CURRENT OUTPUT
OMEGA
ENGINEERING, INC.
OM3
CURRENT OUTPUT
OMEGA
ENGINEERING, INC.

Modular Power Supplies

The OM3 Series Subsystem can operate from a common ac power supply or dc/dc (+24 V input) power supply mounted on the backplane or external ±15 V and +24 V supplies can be used. The power supply is bussed to all signal conditioners on the backplane. Supply current is a function of the modules that are actually used (see Table below). The power supply outputs listed in th Specifications cover most cases. Each power supply operates over a −25°C to +71°C temperature range.

If the user wishes to use a +15 V supply for current output, the +15 V can be strapped to the loop power on connector P3. With this arrangement the load resistance on current output is limited to 400 Ω max.

If +24 V is supplied from an external source, a dc/dc converter (OMX-1302 can be used to supply ±15 V to the backplane. The current loop power is provided from the +24 V source which must be capable of handling the desired number of current loop outputs.

If both +24 V and ±15 V are supplie from an external source, the power supply requirements must be satisfie for the desired number of modules.

Power Requirement Table

Model	+15 V dc Current	−15 V dc Current	+ 24 V d Curren
OM3-mV	10 mA	10 mA	27 mA
OM3-V	10 mA	10 mA	27 mA
OM3-I	10 mA	10 mA	27 mA
OM3-A	10 mA	10 mA	27 mA
OM3-P3	20 mA	20 mA	27 mA
OM3-P4	20 mA	20 mA	27 mA
OM3-S	45 mA	10 mA	27 mA
OM3-VI	4 mA	4 mA	27 mA
OM-ImV	10 mA	10 mA	27 mA
OM-IV	10 mA	10 mA	27 mA
OM-II	10 mA	10 mA	27 mA
OM-IP	10 mA	10 mA	27 mA
OM-ITC	10 mA	10 mA	27 mA
OM3-IVI	5 mA	5 mA	35 mA

The total current required for a system is the sum of the currents used by each module. To determine the power supply requirements for your system, simply add the current specifications for each module from the table above. Each requirement must be met. If +24 V is not used, add this current to the +15 V value to ensure that the system will operate correctly.

SYSTEM

Power Supplies

Module OMX-1300 200 mA

	Input Voltage
No Suffix	105 to 125 V ac, 50 to 400 Hz
"E" Suffix	205 to 240 V ac, 50 to 400 Hz
"F" Suffix	90 to 110 V ac, 50 to 400 Hz
"H" Suffix	220 to 260 V ac, 50 to 400 Hz
Output Voltage	±15 V
Output Current	±200 mA
Operating Temperature	−25°C to +71°C
Storage Temperature	−25°C to +85°C
Dimensions (inches)	3.5 × 2.5 × 1.25

$99

OMEGA ENGINEERING, INC.
OMX-1300
POWER SUPPLY
INPUT: 115 V ac
OUTPUT: ±15 V dc 200 mA

Module OMX-1301 350 mA

	Input Voltage
No Suffix	105 to 125 V ac, 50 to 400 Hz
"E" Suffix	205 to 240 V ac, 50 to 400 Hz
"F" Suffix	90 to 110 V ac, 50 to 400 Hz
"H" Suffix	220 to 260 V ac, 50 to 400 Hz
Output Voltage	±15 V
Output Current	±350 mA
Operating Temperature	−25°C to +71°C
Storage Temperature	−25°C to +85°C
Dimensions (inches)	3.5 × 2.5 × 1.62

$134

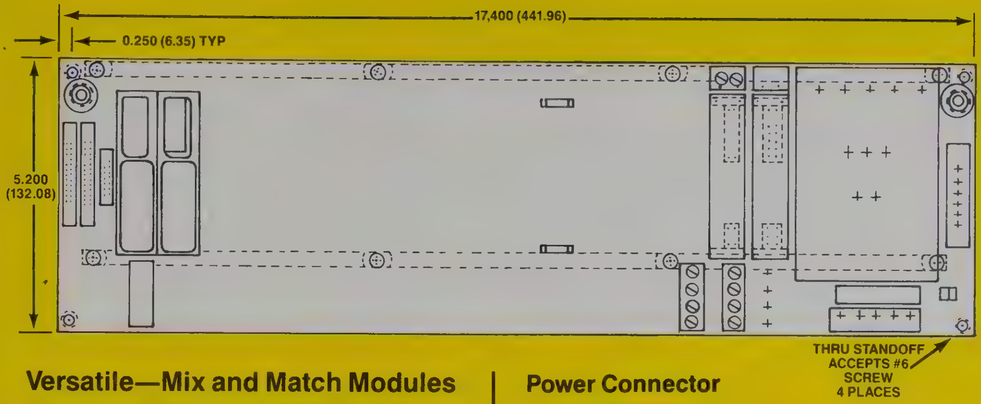
Model OMX-1302 DC INPUT

Input Voltage	22.3 V to 26.4 V
Output Voltage	±15 V
Output Current	±190 mA
Operating Temperature	−25°C to +71°C
Storage Temperature	−40°C to +100°C
Dimensions (inches)	2.0 × 2.0 × 0.38

$106

OMEGA ENGINEERING, INC.
OMX-1302
POWER SUPPLY
INPUT: 24 V dc
OUTPUT: ±15 V dc, 190 mA

Backplanes



Versatile—Mix and Match Modules

The OM3 Backplanes can accommodate 4, 8, or 16 OM3 Series Modules which can be mixed and matched in the backplane to provide the desired number of channels for a specific function. Each channel has four screw terminals for input connections. These connections satisfy all transducer inputs and provide transducer excitation when necessary. A cold junction sensor is supplied on each channel to accommodate thermocouple modules. Each channel has two screw terminals for the output connections for the 4-20 mA output. 26 pin system connectors provide high level voltage I/O for all channels.

Backplanes

- **4, 8, or 16 Channels**
- **Accepts all OM3 Modules**
- **Connectors Included**

OM3-BP-16 **16 Position**	**$345**
OM3-BP-8 **8 Position**	**240**
OM3-BP-4 **4 Position**	**120**

Accessories

Spare 26 Pin Ribbon Cable Connector **OMX-1312**	**10**
2 Ft Ribbon Cable with Two Connectors **OMX-1315**	**19**
3 Ft Ribbon Cable with One Connector **OMX-1354**	**19**
Power Cord **OMX-1340**	**7**
Spare Module Jumpers Pkg of 10 **OMX-1344**	**2**

Power Connector DC Power

1	○	LOOP V +
2	○	LOOP COM
3	○	NC
4	○	+ 15 V
5	○	±15 V COM
6	○	−15 V

BOTTOM VIEW

(Supplied with each Backplane)

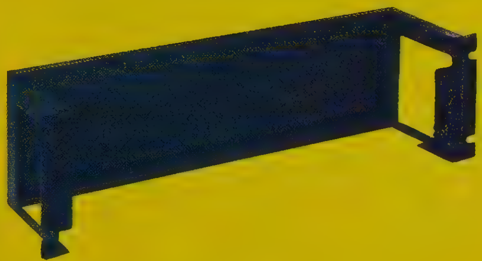
System Connector High Level Analog I/O

CH 0	1	○	○	2	CH 8
COM	3	●	○	4	CH 9
CH 1	5	○	●	6	COM
CH 2	7	○	○	8	CH 10
COM	9	●	○	10	CH 11
CH 3	11	○	●	12	COM
CH 4	13	○	○	14	CH 12
COM	15	●	○	16	CH 13
CH 5	17	○	●	18	COM
CH 6	19	○	○	20	CH 14
COM	21	●	○	22	CH 15
CH 7	23	○	●	24	COM
SENSE	25	○	○	26	NC

BOTTOM VIEW

● = GROUND

(Supplied with each Backplane)



19″ Rack Mount Adaptor Kit for OMX3-BP-16 Backplane

OMX-1330	**$30**

Surface Mount Adaptor Kits for all OM3 Backplanes

16 Channel OMX-1331	**30**
8 Channel OMX-1332	**30**
4 Channel OMX-1333	**30**

OMEGA ENGINEERING, INC.
OMX-1304
POWER
SUPPLY
INPUT: 115 V ac
OUTPUT: ±15 V dc, 200 mA
+5 V dc, 4000 mA
OM4 LIMIT ALARM

DISPLAY, ALARM AND CONTROL

OM4 SERIES

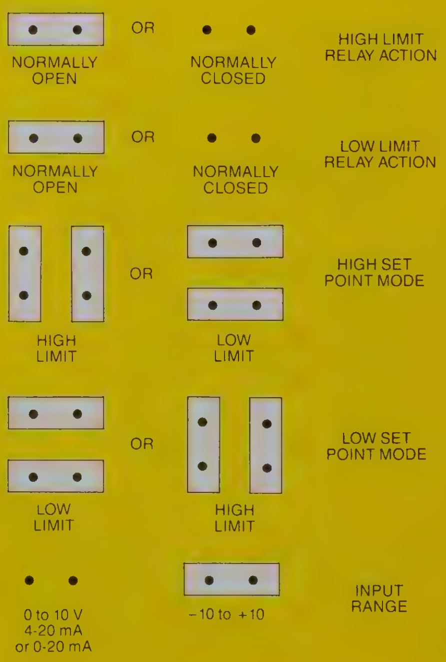
OM4 Design Features:

The OM4 Series Alarm Limit Subsystem is designed to provide an easy and convenient solution to alarm/annunciation problems in measurement and control applications. In a typical application, the OM4 Series Alarm Subsystem provides alarm indication for any sensor input when used with the OM3 Series Signal Conditioning Subsystem. The OM3 Series interfaces directly to sensors and converts the input to the standardized high level analog signal that the OM4 Series monitors. This modular approach provides a very flexible means to alarm indication since the same OM4 module can be used to alarm a variety of sensors when used with the appropriate OM3 module. The OM4 Series can also provide alarm indication or ON/OFF control when used with field transmitters or any other device that provides a process current or high level voltage output.

Direct interface via screw-terminals or ribbon cable, two screwdriver adjustable setpoints per module, adjustable dead band per setpoint, a three digit display that indicates the value of the process variable and setpoints, and the modular design make the OM4 Series Subsystem extremely easy to use.

The OM4 modules have five user programmable jumper options. Each unit can be configured for unipolar or bipolar inputs, both setpoints can be configured for HI or LO limit operation, and both relays can be configured for Normally Open (NO) or Normally Closed (NC) operation. These options allow the user to readily tailor the OM4 units to his specific needs. For instance, if HI-HI operation were required, it is available by changing the appropriate jumpers. All modules are shipped from the factory configured for unipolar input, NO relay action, and HI-LO operation.

Jumper Programming


NORMALLY OPEN
OR
NORMALLY CLOSED
HIGH LIMIT RELAY ACTION
NORMALLY OPEN
OR
NORMALLY CLOSED
LOW LIMIT RELAY ACTION
HIGH LIMIT
OR
LOW LIMIT
HIGH SET POINT MODE
LOW LIMIT
OR
HIGH LIMIT
LOW SET POINT MODE
0 to 10 V
4-20 mA
or 0-20 mA
−10 to +10
INPUT RANGE

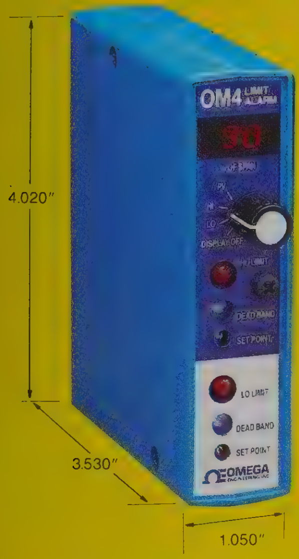
Alarm Module Specifications

(typical @ +25°C and ±15 V, +5 V dc power)

Output	
(2SPST Relays)	Resistive Rating: 3A @ 120 V ac or 24 V dc
Performance	
Accuracy	±0.1% span
Normal Mode Input Protection	130 V rms
Normal Mode Rejection 50 Hz or 60 Hz	20 dB
Features	
Two Setpoints per Module	Adjustable over 100% span by 25 turn potentiometers
Dead band per Setpoint	0.5%-10.0% span, adjustable by 1 turn potentiometer
Relay Action	Field reversible by jumper change
Alarm Status Readback	TTL Level
External Override Signal	TTL Level
Power Supply	
Voltage, Operating	±12 to ±18 V, +4.5 to 5.5 V
Current	±12 mA, +150 mA
Environmental	
Temperature Range, Rated Performance	0 to 70°C

THREE STEPS TO A SYSTEM

1. Order Modules



Dual Setpoint Alarm Modules with 3 Digit LCD Readout

OM4-DA-V	0 to 10, ±10 V dc Input	$160
OM4-DA-0I	0-20 mA Input	160
OM4-DA-4I	4-20 mA Input	160

OM4 LIMIT ALARM
OM4 LIMIT ALARM
OMEGA
OMEGA

Dual Setpoint Nonindicating Alarm Modules

OM4-A-V	0 to 10, ±10 V dc Input	$110
OM4-A-0I	0-20 mA Input	110
OM4-A-4I	4-20 mA Input	110

2. Order Backplane and Power Supply

Power Supplies

OMX-1303 .... **$125**

Output

±15 V @ 150 mA
+ 5 V @ 1000 mA

Input

105-125 V ac	**OMX-1303**
205-240 V ac	**OMX-1303E**
90-110 V ac	**OMX-1303F**
220-260 V ac	**OMX-1303H**

Power Supply

OMX-1304 .... **$175**

Output

±15 V @ 200 mA
+ 5 V @ 4000 mA

Input

105-125 V ac	**OMX-1303**
205-240 V ac	**OMX-1303E**
90-110 V ac	**OMX-1303F**
220-260 V ac	**OMX-1303H**

OMEGA ENGINEERING INC.
OMX-1304
POWER SUPPLY

Backplanes

4 Position Backplane	**OM4-BP-4**	**$150**
12 Position Backplane	**OM4-BP-12**	**345**

The OM4 backplanes are different from the OM3 backplanes and can accommodate 4 to 12 alarm modules. These modules can be mixed and matched in the backplane to provide the desired number of alarm functions for a specific system. Each channel can accept its input from two screw terminals or from the voltage input connector. Each channel has four screw terminals for the two relay outputs. A 26 pin connector provides high level voltage inputs for all channels and a 50 pin connector provides two alarm readbacks and two external overrides for each channel.

19″ Rack Adaptor for OM4 Backplanes

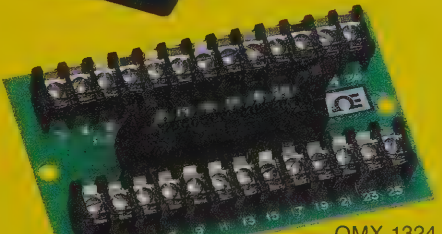
OMX 1334 .... **$30**

3. Order Accessories

Accessories

OMX-1344	Package of 20 Spare Programming Jumpers	**$ 2**
OMX-1342	100Ω Spare Current Shunt Resistor	**4**
OMX-1343	2 K Ω Spare Current Shunt Resistor	**4**
OMX-1347	250Ω Spare Current Shunt Resistor	**4**
OMX-1340D	Power Cord	**6**
OMX-1345	Individual OM3 Module Mounting Kit	**10**
OMX-1348	Individual OM4 Module Mounting Kit	**10**

OMX-1312



OMX-1324

Signal Cables and Connectors

OMX-1312	26 Pin Female Ribbon Connector	**$10**
OMX-1317	26 Pin Male Board Mounting Connector	**10**
OMX-1324	26 Pin Female Connector to Screw Terminals	**40**
OMX-1315	2′ Cable with 2 Connectors	**19**
OMX-1354	3′ Cable with 1 Connector	**19**

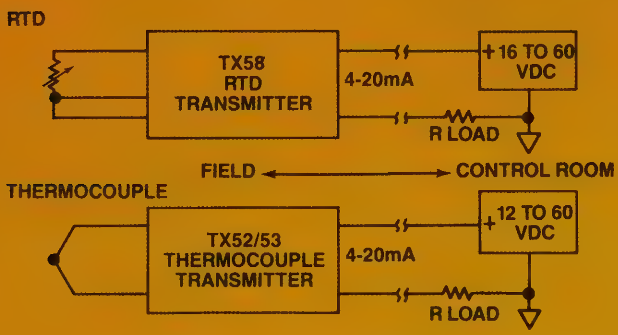
2 Wire Transmitter
Thermocouple or RTD Input

NEW!

- 4-20mA output
- Low cost
- Output error: 0.1% of span
- Low drift
- Thermocouple and RTD

OMEGA ENGINEERING, INC.
TX 52
THERMOCOUPLE TRANSMITTER
Z S
T.C.
OUTPUT
1 2 3 4 5 6
TX 53

Mounting track: $2/ft.
Catalog No. RT-[*]
*Specify length


RTD
TX58
RTD
TRANSMITTER
4-20mA
+16 TO 60
VDC
R LOAD
FIELD
CONTROL ROOM
THERMOCOUPLE
TX52/53
THERMOCOUPLE
TRANSMITTER
4-20mA
+12 TO 60
VDC
R LOAD

From
$160

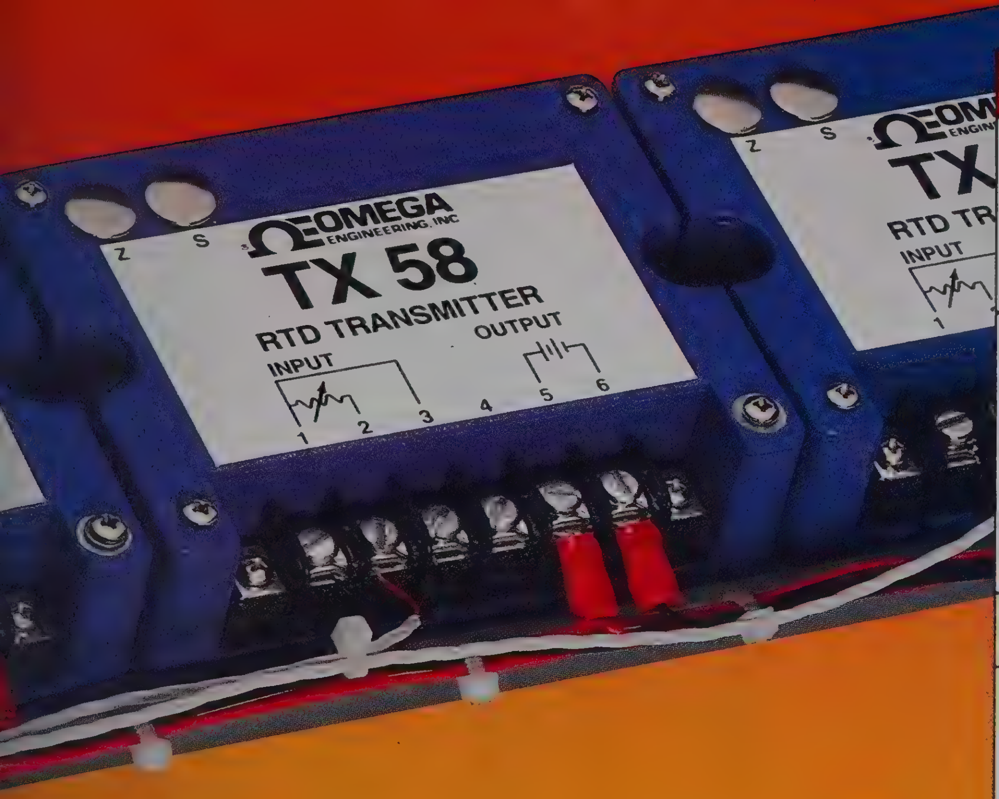
Transmitters provide a two-wire output with the same wiring used for power and output. The load resistance is connected in series with a dc power supply, and the current drawn from the supply is the 4-20mA output signal which is proportional to the measured temperature.

Two-wire current transmission permits remote mounting of the transmitter near the sensor to minimize the effects of noise and signal degradation to which low level sensor outputs are susceptible.

A rugged metal enclosure, suitable for field mounting, offers environmental protection and screw terminal input and output connections. This enclosure may be either surface or standard relay track mounted.

- **Thermocouples**
  OMEGA models TX52 and TX53 are high performance, low cost temperature transmitters designed to accept a thermocouple input from types J, K or T and produce a standard 4-20mA output current proportional to the measured temperature. The TX52 features high input to output isolation (600 V rms) and high CMR (160dB @ 60Hz). The TX53 offers a functionally equivalent design without input to output isolation.

- **Platinum RTD**
  Model TX58 accepts 2-wire or 3-wire 100Ω platinum resistance sensors ($\alpha = 0.00385\ \Omega/\Omega/°C$) and provides a linearized output.



Rugged Metal Case

In Stock for Immediate Delivery

RANGES AVAILABLE

Sensor Type	Range Code	Input Ranges	
"T" Thermocouple (Copper-Constantan)	T1 T2	−100°C to + 300°C 0°C to + 200°C	−148 to + 572°F + 32 to + 392°F
"J" Thermocouple (Iron-Constantan)	J1 J2 J3	0°C to + 500°C −100°C to + 300°C 0°C to + 750°C	+ 32 to + 932°F −148 to + 572°F + 32 to +1382°F
"K" Thermocouple (Chromel-Alumel)	K1 K2 K3	−100°C to + 300°C 0°C to + 600°C 0°C to +1000°C	−148 to + 572°F + 32 to +1112°F + 32 to +1832°F
Platinum 100Ω RTD ($\alpha = 0.00385$)	Pt1 Pt2 Pt3 Pt4	−100°C to + 100°C 0°C to + 100°C 0°C to + 200°C 0°C to + 400°C	−148 to + 212°F + 32 to + 212°F + 32 to + 392°F + 32 to + 752°F

How to Order

Isolated (Input to Output) Thermocouple Range **TX-52-[*]**	**$225**
Non-isolated Thermocouple Range **TX-53-[*]**	**$160**
Platinum RTD Range—non-isolated **TX-58-[*]**	**$175**

**Insert Range Code*

Specifications

Output Specifications

Output Span	4-20mA
Minimum Output Current	3.5mA, typ
Maximum Output Current	40mA, typ
Output Protection[1]	±60V

Accuracy

Total Output Error[2]	±0.1%
Stability vs. Ambient Temperature	
Zero	°C/°C max
Span	±0.005%/°C
Stability vs. Time[2]	±50ppm/Month
Warm-up Time to Rated Performance	3 Minutes

Response Time

To 90% of Span	0.4 sec

Environmental

Temperature Range, Rated Performance	−30°C to +85°C
Storage Temperature Range	−55°C to +125°C
Relative Humidity, Non-condensing	0 to 90%
RFI Effect (5W @ 470MHz @3 ft.) Error	±0.5% of Span

Physical

Case Size	4″ × 3.25″ × 1.25″
Weight	8 oz. (227 grams)

NOTES

[1] Protected for reverse polarity and for any input/output connection combination

[2] Accuracy is specified as a percent of output span (16mA). Accuracy spec includes combined effects of transmitter repeatability, hysteresis and linearity. Does not include sensor error.

Complete Your System Model TX-81 4-20 mA Loop Display

$229

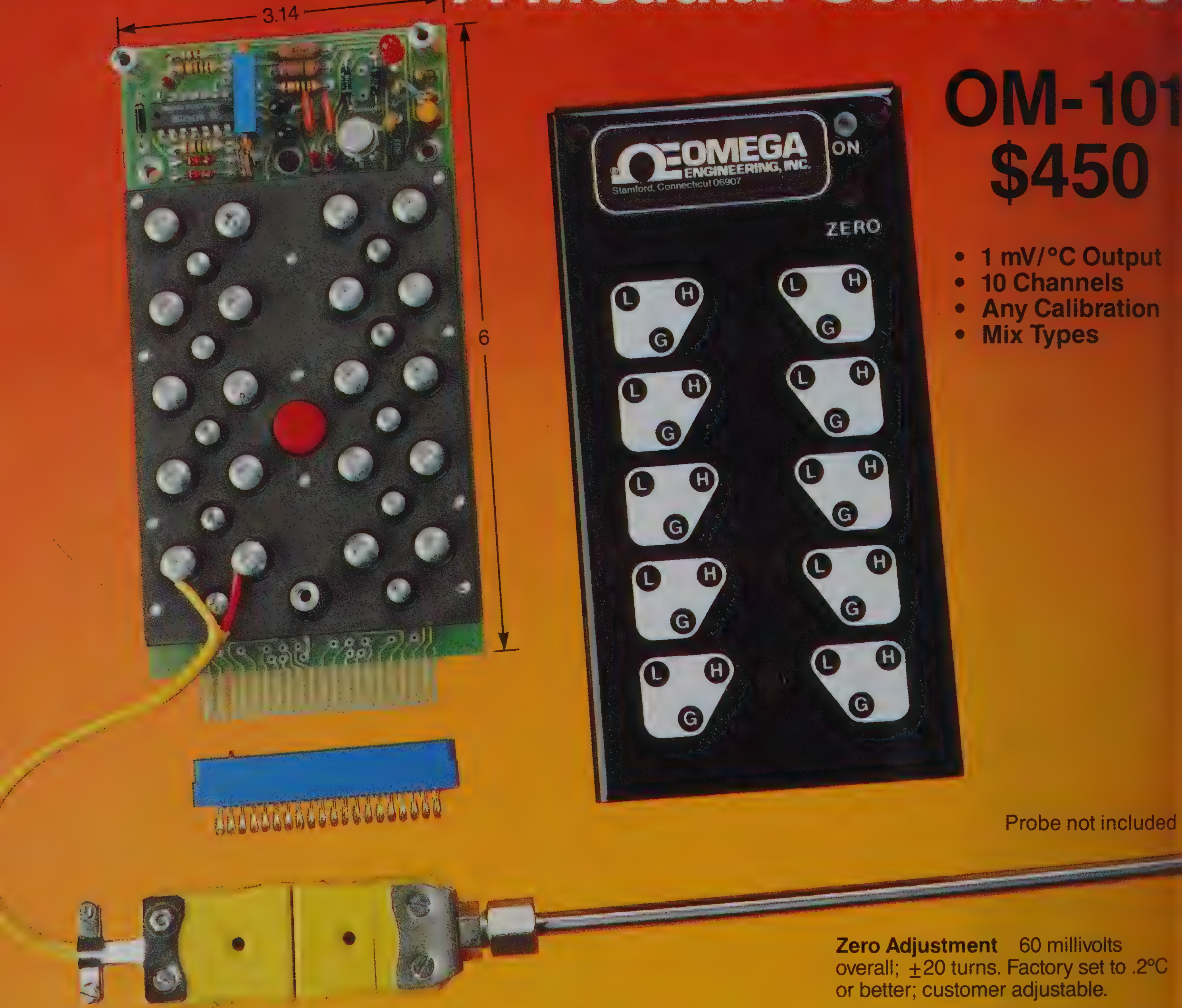
See page L-13 for complete details.

1999
OMEGA ENGINEERING, INC.
PROCESS INDICATOR TX-81

A Modular Solution to

OM-101
$450

- 1 mV/°C Output
- 10 Channels
- Any Calibration
- Mix Types



Probe not included

The OM-101 Ten Channel Modular Reference Junction

The OM-101 tracks the temperature at which your thermocouples are terminated and provides a 1 mV/°C signal for your computer to perform cold junction compensation in software.

- **Ideal for use with microprocessors and data acquisition modules**
- **Any wire type with only software coefficients**
- **Economical: ten full channels**
- **Isothermal assembly with rugged terminals**
- **Precision electronic thermometer assembly never needs calibration**

Compensation Error Within or equal to ±.01°C/°C ±.1°C about a midpoint of 25°C ±20°C.*

Compensation Stability Aged, premium-grade silicon sensor produces long-term stability within .001°C/°C per year.

Zero Adjustment 60 millivolts overall; ±20 turns. Factory set to .2°C or better; customer adjustable.

Output Impedance Less than 900 ohms. Short circuit and overvoltage protected.

Line Regulation Within .03°C/volt relative to DC supply voltages.

Power Requirements +14 to +16 volts; 19 mA max. −14 to −16 volts; 20 mA max.

Isothermal Uniformity With cover installed, .1°C channel-to-channel; .2°C any channel-to-sensor.

Dielectric Isolation 1000 Megohms at 310 volts peak channel-to-channel or channel-to-compensator.

Ambient Ranges Operating: 0°C to 70°C; storage: −65°C to +155°C. Relative humidity to 95%.

* Each unit is tested across a wide ambient range from 5°C to 45°C and the thermometer is adjusted and permanently sealed to the above specification.

Thermocouple Termination

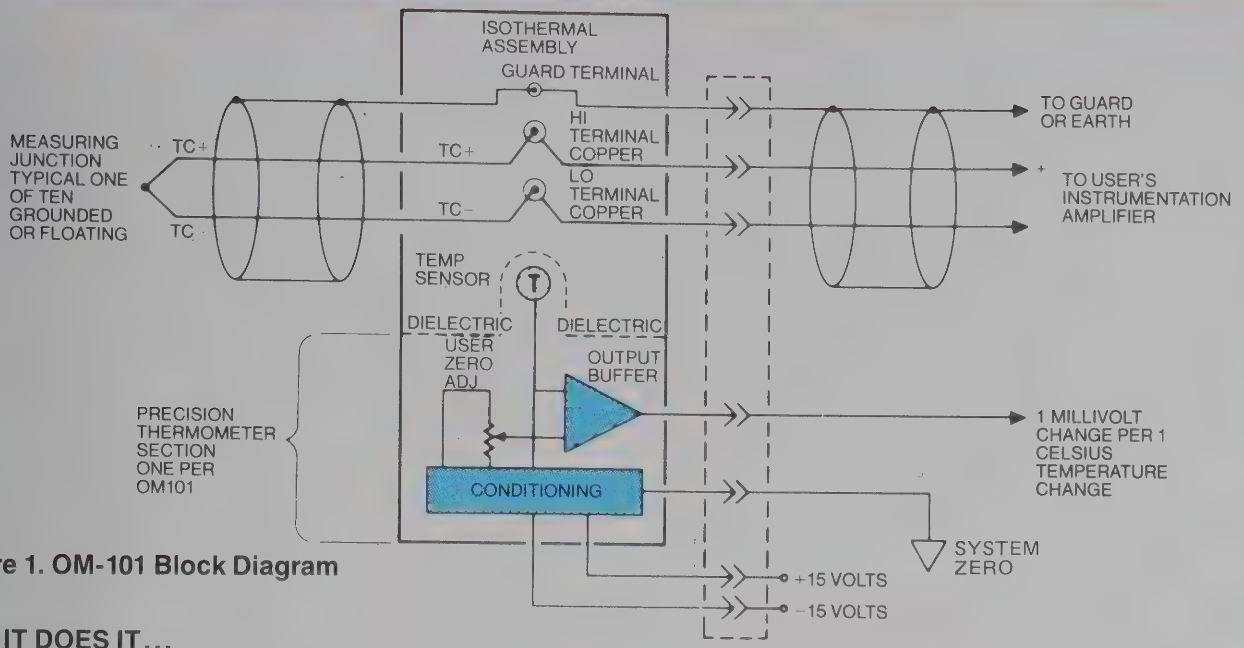

ISOTHERMAL ASSEMBLY
GUARD TERMINAL
MEASURING JUNCTION TYPICAL ONE OF TEN GROUNDED OR FLOATING
TC+
TC
TC+
TC−
HI TERMINAL COPPER
LO TERMINAL COPPER
TO GUARD OR EARTH
+
TO USER'S INSTRUMENTATION AMPLIFIER
TEMP SENSOR
T
DIELECTRIC
DIELECTRIC
USER ZERO ADJ
OUTPUT BUFFER
PRECISION THERMOMETER SECTION ONE PER OM101
CONDITIONING
1 MILLIVOLT CHANGE PER 1 CELSIUS TEMPERATURE CHANGE
SYSTEM ZERO
+15 VOLTS
−15 VOLTS

Figure 1. OM-101 Block Diagram

HOW IT DOES IT…

Every OMEGA reference junction is an electronic design combined with a thermal one (Fig. 1). An aged silicon temperature sensor which is electrically isolated from all thermocouple terminals, but thermally coupled to them, senses the instantaneous temperature of a carefully configured isothermal assembly and through a signal conditioner produces a precision 1 mV/C output signal. This level is used in your software to determine the offset due to the difference between ice point and ambient temperatures. The silicon sensor has a long-term stability which rivals platinum and a linearity exceeding that of platinum. A user zero adjustment is provided as a convenience.

OM-108 Rack Mount for OMEGA® Thermocouple Reference Junctions

OMEGA
ON
ZERO
OMEGA
ON
ZERO
7.62

- Up to 50 Channels Per Panel
- Any Mixture of Wire Types
- Self Contained Power Supply
- Standard 19-inch Rack Width
- Ideal for Microprocessor Software Compensation

$450

To Order
OM-108 $450
Panel and Power Supply Only

Signal Conditioning

Cold Junction Compensation

Simply connect your thermocouple to the input, and the battery powered compensator supplies a mV output referenced to 0°C for use with recorders and voltage readout devices.

OMEGA ENGINEERING INC
COLD JUNCTION COMPENSATOR
(+) OUTPUT (−)
(COPPER-COPPER)
OPEN
OFF
ON
BATTERY TEST
INPUT
(+) (THERMOCOUPLE) (−)
PATS. PENDING

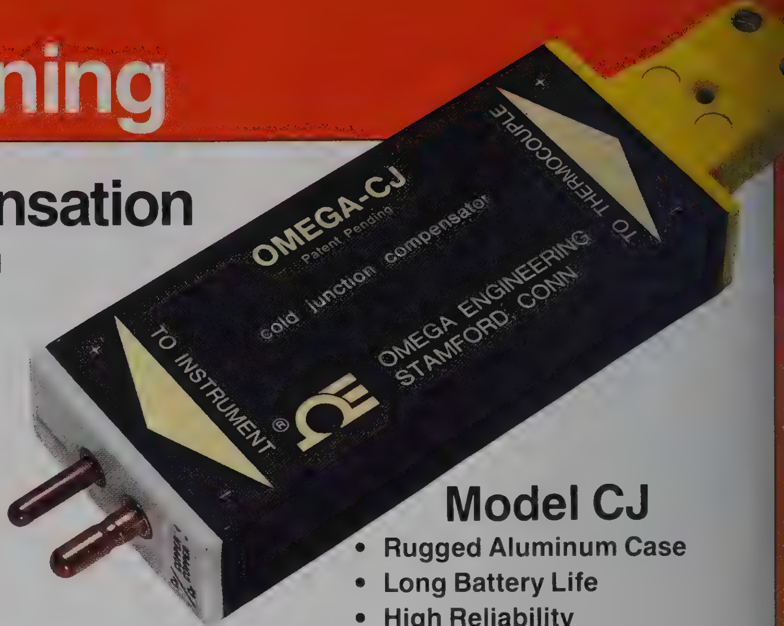
Model MCJ

- Small Size
- High Impact Case
- Color Coded

Specify Thermocouple Type

$72

See **Section K** for complete specifications.


OMEGA-CJ
Patent Pending
cold junction compensator
OMEGA ENGINEERING
STAMFORD, CONN
TO INSTRUMENT
TO THERMOCOUPLE

Model CJ

- Rugged Aluminum Case
- Long Battery Life
- High Reliability
- Output Leads Included
- Nine Calibrations Available Including Tungsten/Rhenium

Prices Start At **$125**

Signal Amplification

THERMOCOUPLE D.C. MILLIVOLT AMPLIFIER
REFERENCE
AMPLIFIER
BATTERY
OMEGA ENGINEERING, INC.
GAIN
ZERO
ADJUST
VOLT/MA
FOR FIXED GAIN
D.C. MILLIVOLT AMPLIFIER
OMEGA ENGINEERING, INC. STAMFORD, CONN

Omni-Amp IIA
Omni-Amp IIB

- Battery Powered
- Heavy Duty Case
- Easy To Use
- Gains From X1 To X100
- Battery Status Indicator
- Voltage or Current Output

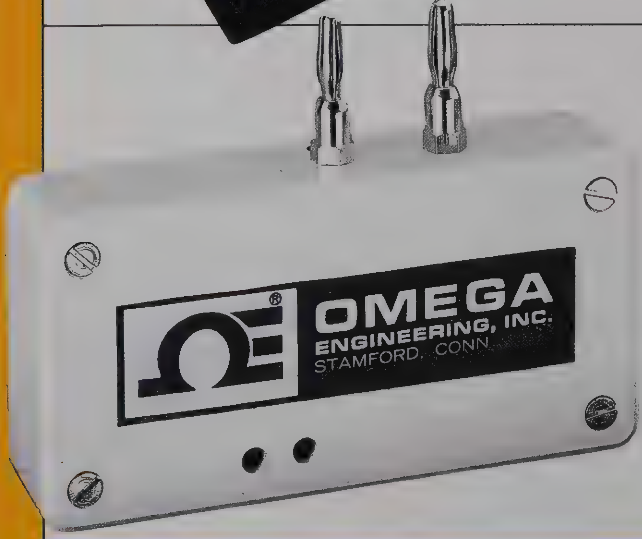
Without Cold Junction Compensation

Model Omni-Amp IIA **$175**

With Cold Junction Compensation (Specify Thermocouple Type)

Model Omni-Amp IIB **$240**

See **Section L** for complete specifications.


OMEGA
ENGINEERING, INC.
STAMFORD, CONN

Thermocouple Linearization

TAC-386

The TAC-386 is a universal thermocouple amplifier and linearizer which provides a precision 1 mV/°C signal for the popular J, K or T thermocouples. Cold junction compensation is standard. Converts mV recorders and multimeters to thermometers.

See **Section N** for complete specifications.

TAC-386-J, TAC-386-K, TAC-386-T

J, K or T Calibration

$125

Battery Included

Analog/RS-232C Interface

YOUR COMPUTER CAN MONITOR TEMPERATURE, PRESSURE, FLOW...ANY PROCESS SIGNAL

with the OMEGA® WHITE BOX™
WB-31 Analog to RS-232C Interface.

- Low Cost
- Easy-to-Use Interface
- Stand Alone System

WB-31
WHITE BOX™
OMEGA ENGINEERING, INC.
ANALOG/RS-232C INTERFACE
OMEGA
OMEGA ENGINEERING, INC.
An OMEGA Group Company
One Omega Drive
Stamford, CT 06907
(203) 322-1666
ON

Price:
$395
WB-31
Off-the-Shelf Delivery

Use with our NEW TAC signal conditioning modules. Probe, cable & adaptors not included. See page N-23.

Computers

- IBM
- DEC
- HEWLETT-PACKARD
- APPLE
- Any mainframe or personal computer with a Serial Port!

Inputs

Any analog process signal 0 to 5 V indicating:

- Temperature
- Pressure
- Flow
- pH
- Humidity

Outputs

4 TTL Outputs Controlled from your computer can activate:

- Solid State Switches
- Relays
- Alarms
- Process Functions

Real World Interface
Model WB-31

A complete analog measurement and digital control package—WHITE-BOX™—WB-31. It's low cost and easy to use. Just connect an analog process signal (between −4.999 and +4.999 volts) to one of the two analog inputs and plug the WB-31 into your computer. No expensive parallel interface or bus configuration cards are needed. Any serial RS-232C or 20 mA port will work!

No special programming is required to use the WB-31. The WB-31 responds just like a computer peripheral. Simple control commands tell it what is to be done and a C will start conversions and transmit data to your computer.

NEED CONTROL?—WB-31 has 4 addressable TTL outputs. Not only can your computer monitor your process, it can control it! The four outputs can sound alarms, work heaters and air conditioners, start motors, etc., all through solid state switching devices. See pages R-55 to R-58.

Upgrade your process to the computer age!

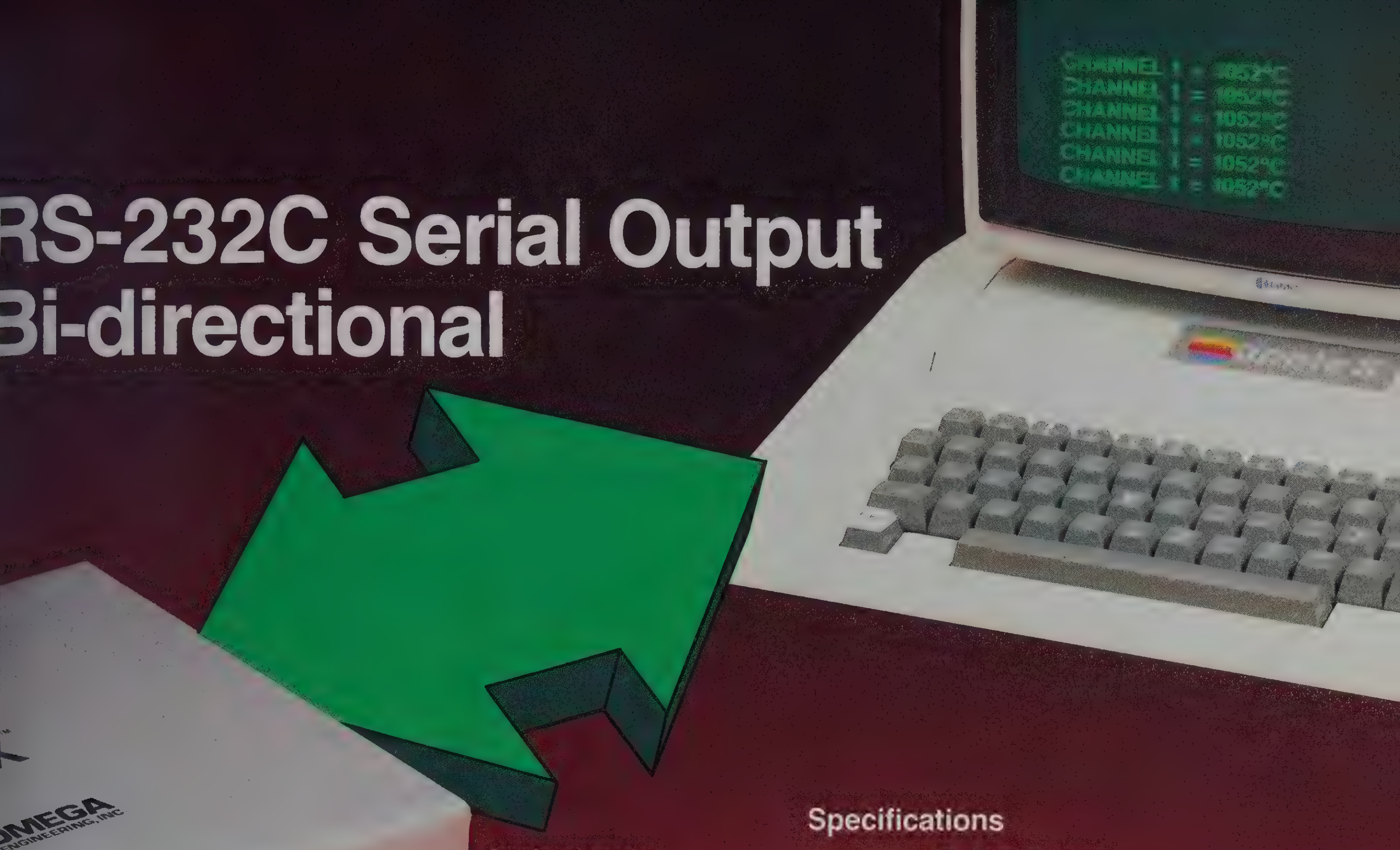
There is no need to replace your existing displays and controllers—if they have an analog output signal, WB-31 can put you into the Computer Age! No more reams of chart paper or all night vigils. WB-31 puts the information into your computer and stands ready to act with its TTL output day and night.

K CHROMEL ALUMEL
1052 °C
OMEGA ENGINEERING MODEL 199
OMEGA

Analog Input

Price:
$395
WB-31
Off-the-Shelf Delivery

RS-232C Serial Output
i-directional


232C INTERFACE
OMEGA ENGINEERING, INC.
CHANNEL 1 = 1052°C

4 TTL Outputs

Specifications

Analog Inputs
- Two analog inputs are provided along with a single A/D converter. Signal selection under computer control.
- Input Range: 0- ±4.999 volts dc (standard)
- 12 bits plus sign
- Resolution 1.25 millivolt

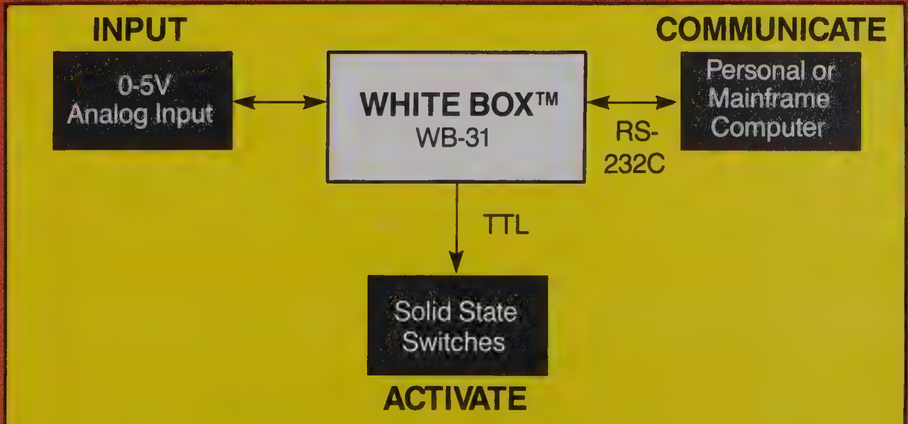
Communications
- RS-232C or 20 mA current loop
- Uses 7 bit ASCII code
- Baud Rate: (110 through 9600 baud), Word Format is selectable by internal DIP switches
- Parity: None, odd or even, switch selectable
- Stop Bit: One or two, switch selectable

Parallel Output
- 4 single bit 40 mA open collector outputs are provided. Each output is controlled individually using control character sequences over the serial line.

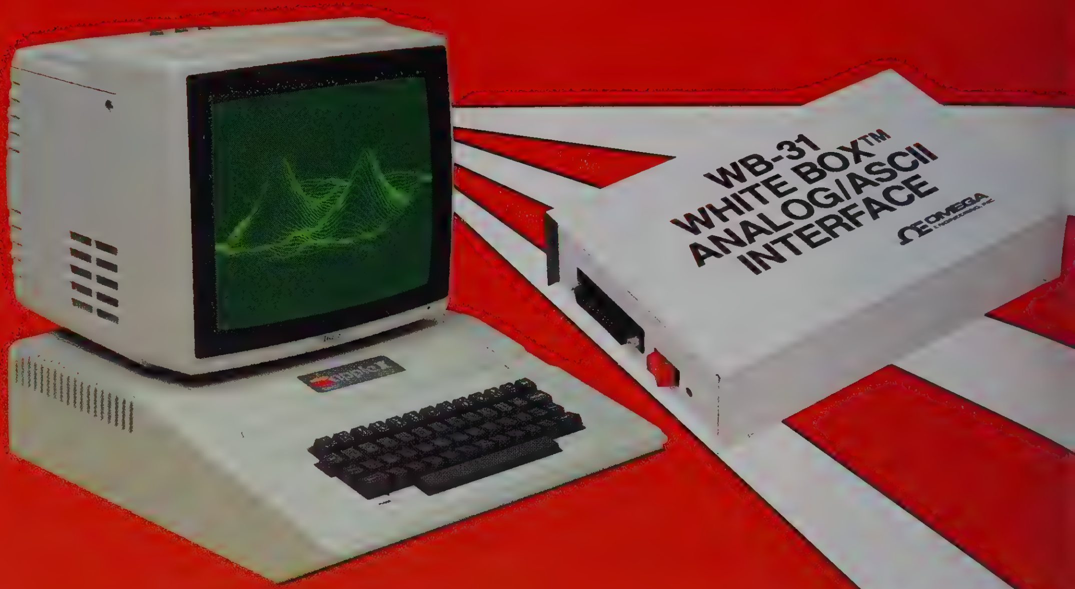
Electrical
- Power is 110 V ac or 220 V ac (internally selectable), 50/60 Hz.

Physical
- Serial I/O connector is standard 25 pin female SUB-D.
- Connections to analog input and parallel output are made via terminal blocks.

Dimensions
- Size: 8.5 in. × 5.5 in. × 1.75 in. Weight: 4 lbs.

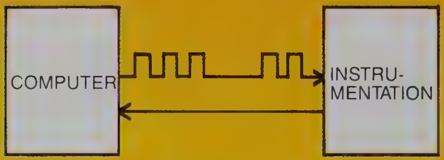

INPUT
0-5V Analog Input
WHITE BOX™
WB-31
COMMUNICATE
Personal or Mainframe Computer
RS-232C
TTL
Solid State Switches
ACTIVATE

The Missing Link—between your process measurement and computer—WB-31

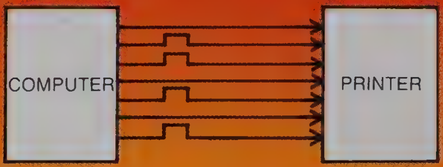


DATA ON RS-232-C COMMUNICATION

Information being transferred between processors is always a pulse train (Digital data) which can be transmitted as 4-bit, 8-bit, 12-bit, 16-bit or 24-bit words. An 8-bit word is usually called a byte, and many communications methods are rated according to their bytes/second transfer rate. Digital data is transferred in either a serial or parallel mode. Serial transmission means that the data is sent as a series of pulses, one bit at a time. One processor clocks the data out while the receiving processor clocks it in, one bit at a time.



Although slower than a parallel system, serial interfaces require only two wires so their cabling cost is low. The speed of serial transmissions are rated according to their bits/second rate, or baud rate. A Teletype, for example, is rated at 110 baud because it transmits ten 11-bit characters per second. Some serial transmission methods—such as those used with very fast CRT's—can reach 9600 baud. In parallel transmission, the entire data word is transmitted at one time. To do this, each bit of a data word has to have its own transmission line. In addition to data lines, there may also be lines for clock pulses and control signals. In other words, to transmit an 8-bit word in parallel, you need at least eight wires. Serial trans mission requires only two wires (one for receive, the other for transmit), but parallel requires at least as many wires as there are bits in a word being transmitted. Obviously, serial transmission must be used for long distance communications where wiring costs are prohibitive. Parallel transmission is used for short distances or when high data rates are required.



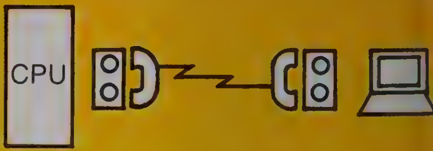
Serial Standards

One of the advantages of a serial system is that it lends itself to transmission over telephone lines. The serial digital data coming down the wire can be converted by a modem, placed onto a standard voice-grade telephone line, and converted back to serial digital by a modem at the other end of the line. Data can be transmitted great distances in this way.

To transmit data over voice-grade lines, the Bell System introduced the Bell 103 modem and defined the interface to it. This interface, RS-232-C, became a de facto standard (it became a standard because every manufacturer conformed to it, not because of any official decree). The RS-232-C standard was eventually adopted by the Electronic Industries Association (EIA) as an official standard for serial communication. It defines pin assignments, signal levels and other electrical considerations for receiving and transmitting devices. You don't need telephone line to use RS-232-C. The standard works just as well with a twisted wire pair. Today, many remote I/O devices and micro-computers use RS-232-C and a twisted pair to transmit and receive information.

Serial ASCII RS-232-C Interfaces

By far the most universal communication interface is Serial ASCII. ASCII code is typically used with a current loop (TTY) interface for long distance communication or with an RS-232-C interface for distances of less than 50 feet. The ASCII control commands were originally designed to be the protocol for a Teletype communication network. The commands controlled the transmittin and receiving of messages between terminals, and determined which Teletype unit would be in control of th asynchronous line at any point in tim Almost every computer produced today has an RS-232-C I/O port, and many peripheral devices are availabl that accept ASCII data. Also, ASCII is the most common method for coding data in the processing business, it is one of the simplest communication methods ever devised, and it is relatively inexpensive.



OPERATE
STANDBY
AUTO
OMEGA
μMEGA
INTELLIGENT SCANNING SYSTEM
OMEGA ENGINEERING, INC.
OMEGA
205

Definition of an ASCII Word

A serial character consists of a start bit (logic "0") followed by data bits, starting with the least significant bit LSB) and ending with the most significant bit (MSB), then an optional parity bit, and finally one or two stop bit(s). The data portion can consist of 5, 6, 7 or 8 bits. The ASCII system is a set of 256 characters and instructions hat is presently the most utilized serial data code (see Glossary).

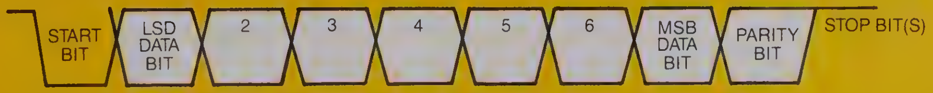
nterface Signal Levels (per EIA):

MARK = OFF = ONE = −3 to −25 V
SPACE = ON = ZERO = +3 to +25 V

Framing:

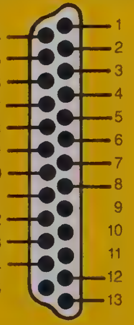
Start bit—always space
Data bits 5, 6, 7, or 8—may be mark or space
Stop bits 1, 1.5, or 2—always mark—idle state

ASCII CHARACTER


START BIT
LSB DATA BIT
2
3
4
5
6
MSB DATA BIT
PARITY BIT
STOP BIT(S)

INTERFACE CONNECTOR PIN ASSIGNMENTS

(PER THE RS-232-C STANDARD)



SIGNAL DESIGNATION	PIN NUMBER	PIN NUMBER	SIGNAL DESIGNATOR
SECONDARY TRANSMITTED DATA	14	1	PROTECTIVE GROUND
DCE TRANSMITTER SIGNAL ELEMENT TIMING	15	2	TRANSMITTED DATA
SECONDARY RECEIVED DATA	16	3	RECEIVED DATA
RECEIVER SIGNAL ELEMENT TIMING	17	4	REQUEST TO SEND
	18	5	CLEAR TO SEND
SECONDARY REQUEST TO SEND	19	6	DATA SET READY
DATA TERMINAL READY	20	7	SIGNAL GROUND/COMMON RETURN
SIGNAL QUALITY DETECTOR	21	8	RECEIVED LINE SIGNAL DETECTOR
RING INDICATOR	22	9	+ VOLTAGE
DATA SIGNAL RATE SELECTOR	23	10	− VOLTAGE
DTE TRANSMITTER SIGNAL ELEMENT TIMING	24	11	
	25	12	SECONDARY RECEIVED LINE SIGNAL DETECTOR
		13	SECONDARY CLEAR TO SEND

SLC II
Communications Controller

The SLC II is a versatile microprocessor based communications controller that provides your computer system with a wide range of useful capabilities. Most often, the SLC II is used to monitor information being transmitted between devices and to perform actions based on the triggers it receives. You define the triggers and corresponding actions.

$3900

IT TALKS TO YOU!
02

Standard Features

Your SLC II is equipped with an easy-to-use version of BASIC programming and with 16K bytes of RAM memory.

In addition, your SLC II includes:

- **a 24 hour clock and 100 year self-correcting calendar**
- **a speech synthesizer with a 300-plus word vocabulary and the ability to spell words that are not in its vocabulary**
- **a built in auto-dial auto-answer modem**
- **rechargeable batteries**

The 100 year calendar is self-correcting in the sense that it automatically accounts for the 29th day of February during leap years with no interaction from the user.

The speech synthesizer in the SLC II may be used to communicate over the unit's front panel speaker, over the telephone, or through an external audio amplifier.

The auto-dial feature enables the SLC II to automatically dial up to 85 pre-set telephone numbers and deliver any given message.

The SLC II is also equipped with self-recharging batteries which keep the clock and calendar accurate even when the main power is removed.

Programming Characteristics

You can program your SLC II to recognize up to 32 distinct key phrases or KEYs transmitted from the host computer. You can define a maximum of 85 actions for the SLC II to perform automatically whenever it detects a KEY. In addition, you can program the following data structures to be used in specifying actions for the SLC II to perform:

- **up to 85 Phone Numbers to be dialed**
- **up to 85 Sentences to be spoken**
- **up to 85 Responses to be sent to the host computer, printer, console, or other peripheral device**

μMEGA
INTELLIGENT SCANNING SYSTEM
OMEGA
AUTO
LINE
RESET
MAN
LCL
REV
COL
SEL
SND
15 21 26
SLC II
OMEGA ENGINEERING, INC.
STAMFORD, CT

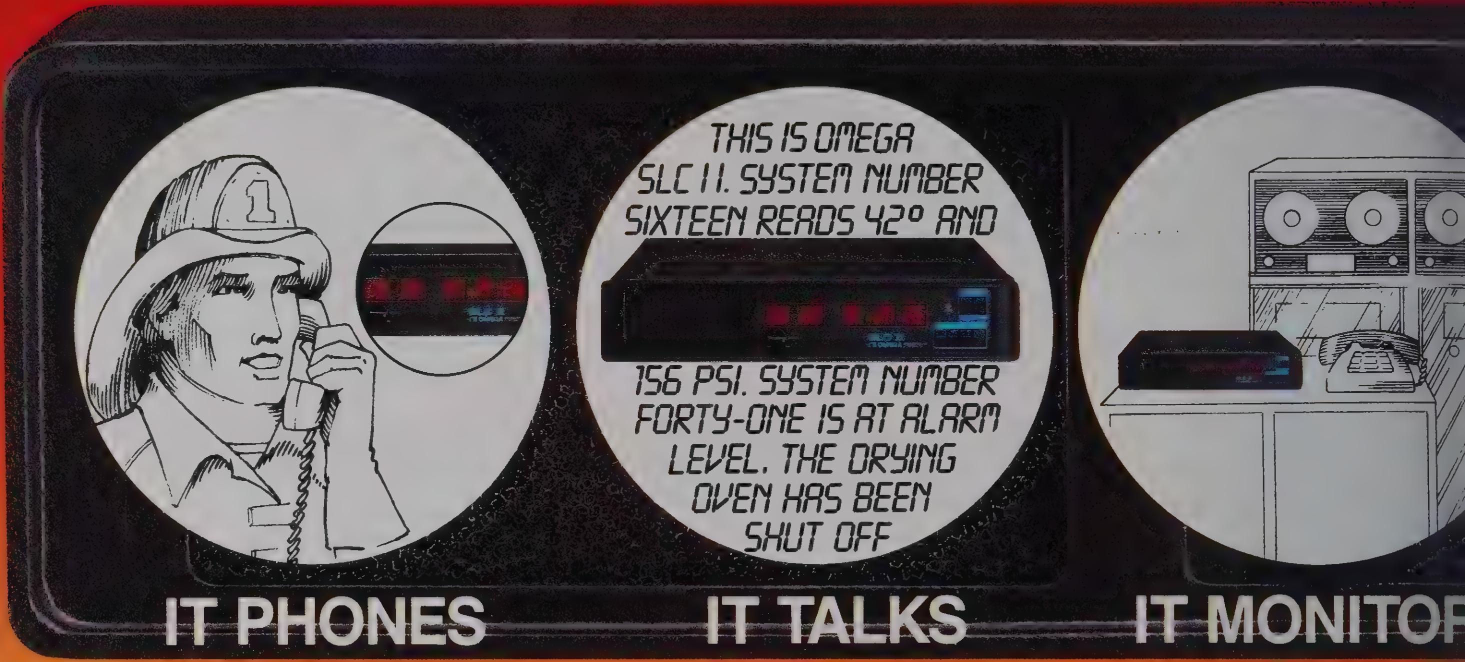
SLC II DATA STRUCTURES

The SLC II provides a maximum of 85 Buffers for use in storing information gathered from the host computer or peripheral devices. In addition, you may define up to 16 Timers that nstruct the SLC II to perform specific actions at regular intervals or at a particular point in time.

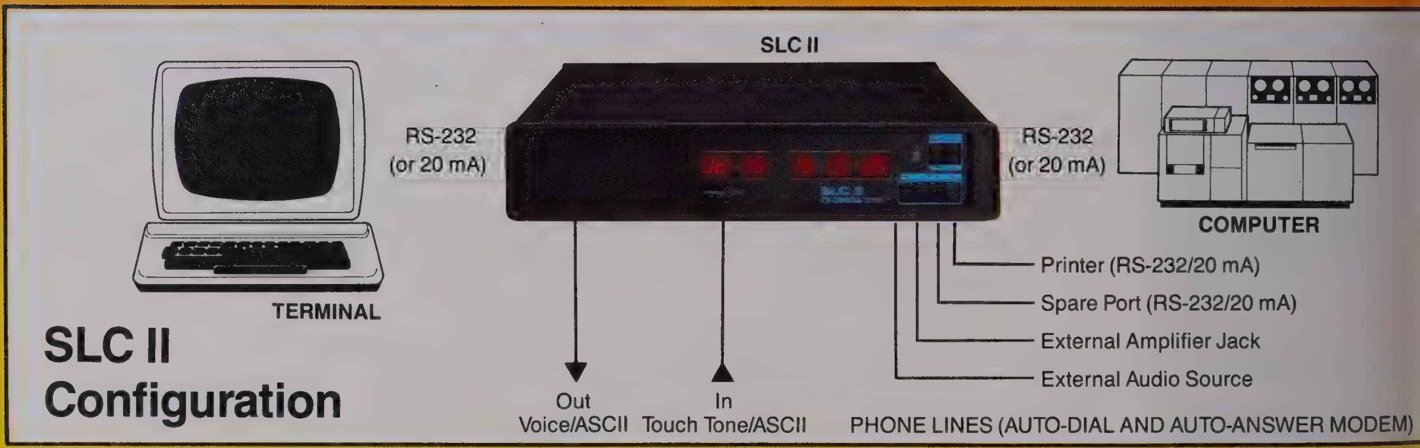
The number and range of SLC II data structures make the unit a truly powerful and flexible device. And since these structures are stored in he unit's battery-supported memory, t is highly unlikely that you will ever have to reenter information because of a power failure.

85 Sentences
32 Keys
85 Phone Numbers
85 Responses
16 Timers
85 Buffers
16 Events
16 Outputs
85 Actions

SLC II Talking Monitor


THIS IS OMEGA SLC II. SYSTEM NUMBER SIXTEEN READS 42° AND 156 PSI. SYSTEM NUMBER FORTY-ONE IS AT ALARM LEVEL. THE DRYING OVEN HAS BEEN SHUT OFF
IT PHONES
IT TALKS
IT MONITOF

MONITOR REMOTE LOCATIONS


SLC II
TERMINAL
RS-232 (or 20 mA)
RS-232 (or 20 mA)
COMPUTER
Printer (RS-232/20 mA)
Spare Port (RS-232/20 mA)
External Amplifier Jack
External Audio Source
Out Voice/ASCII
In Touch Tone/ASCII
PHONE LINES (AUTO-DIAL AND AUTO-ANSWER MODEM)

SLC II Configuration

Configuring the SLC II

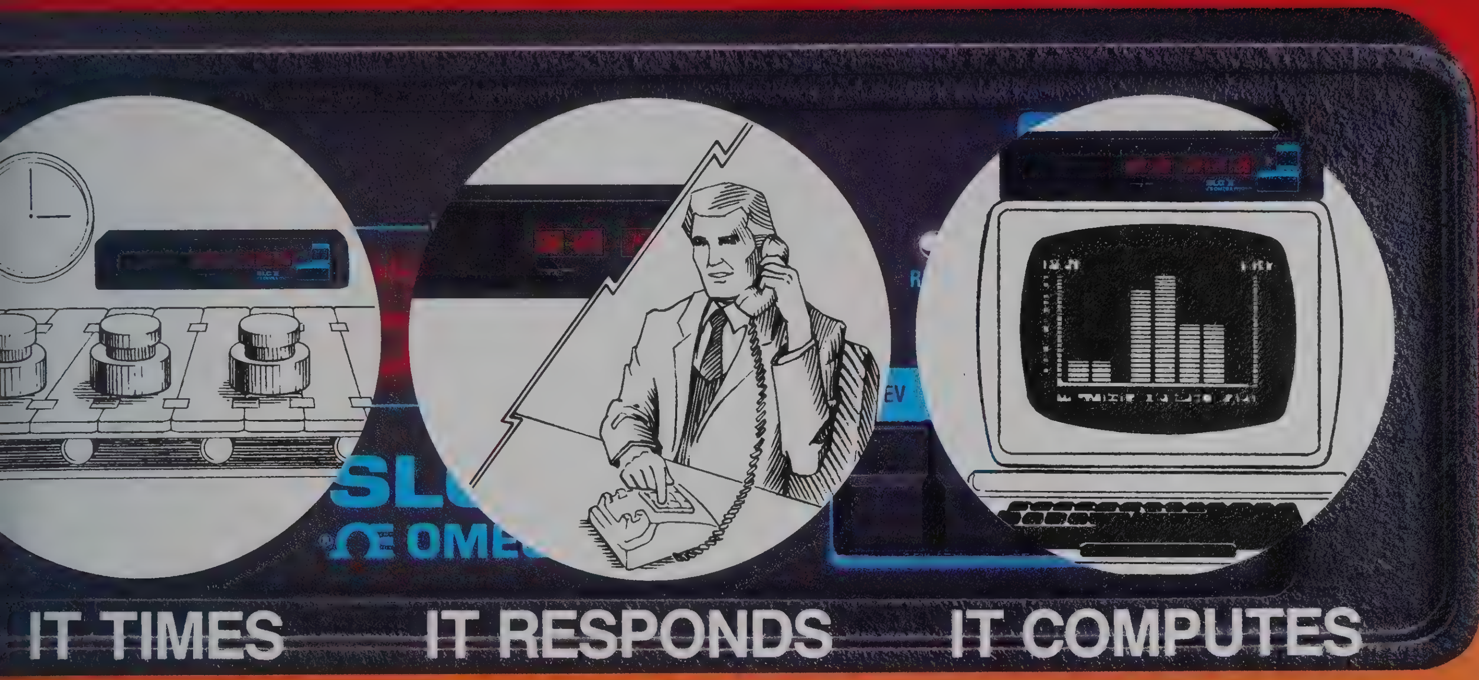
The **SLC II** can be connected to many different types of devices and configured to operate in a wide variety of modes. The maximum configuration for the SLC II is depicted above. The SLC II uses standard interfaces and can be easily installed without changing your operating software.

The SLC II can be connected to different devices in a variety of ways. To connect a device to your SLC II, plug one end of an RS-232C cable into one of the rear panel connectors and plug the other end into the connector on the device.

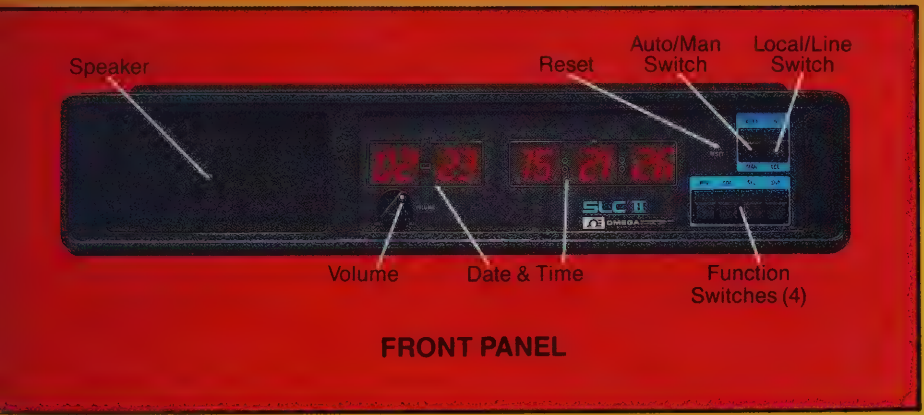
SLC II Specifications

Power Requirement	115 V ac, 60 Hz or 230 V ac, 50 Hz
Power Supply	+5 V dc @ 6 A +12 V dc @ 2 A −12 V dc @ 2 A
Battery Power	+3.6 V dc @ 30 μA
Baud Rate	75 to 9600 Selectable in 10 steps
Interface	Four ports of EIA RS 232C or 20 mA asynchronous

Processor	1.5 MHz (6502) 16.32 K RAM
Mechanical Size	14 × 16.75 × 3.5 Rack mountable (35.6 cm × 43.22 cm × 8.90 cm)
Weight	14 lbs. (6.35 kg)
Display Characters	0.6 (1.5 cm) Seven segment LED displays dat and time.


SLC
OMEGA
IT TIMES
IT RESPONDS
IT COMPUTES

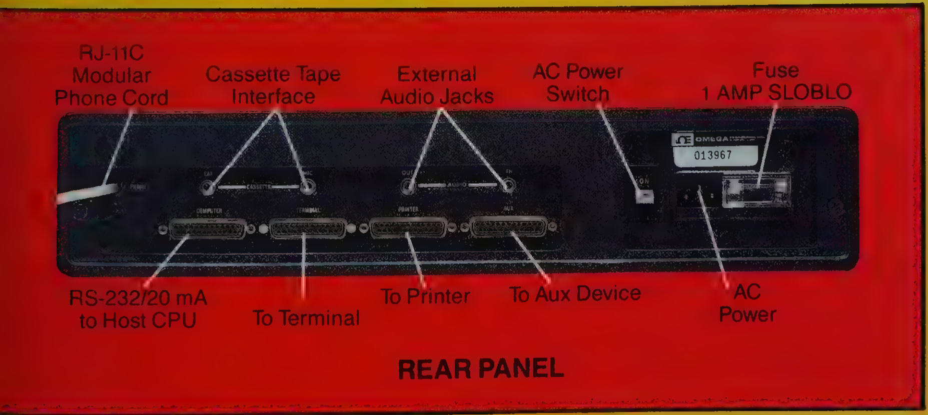
THE SLC II IS ALERT 24 HOURS


Speaker
Reset
Auto/Man Switch
Local/Line Switch
Volume
Date & Time
Function Switches (4)

FRONT PANEL

Operating Controls

The operating controls of your SLC II are positioned on the unit's front and ear panels, as shown.


RJ-11C Modular Phone Cord
Cassette Tape Interface
External Audio Jacks
AC Power Switch
Fuse 1 AMP SLOBLO
RS-232/20 mA to Host CPU
To Terminal
To Printer
To Aux Device
AC Power

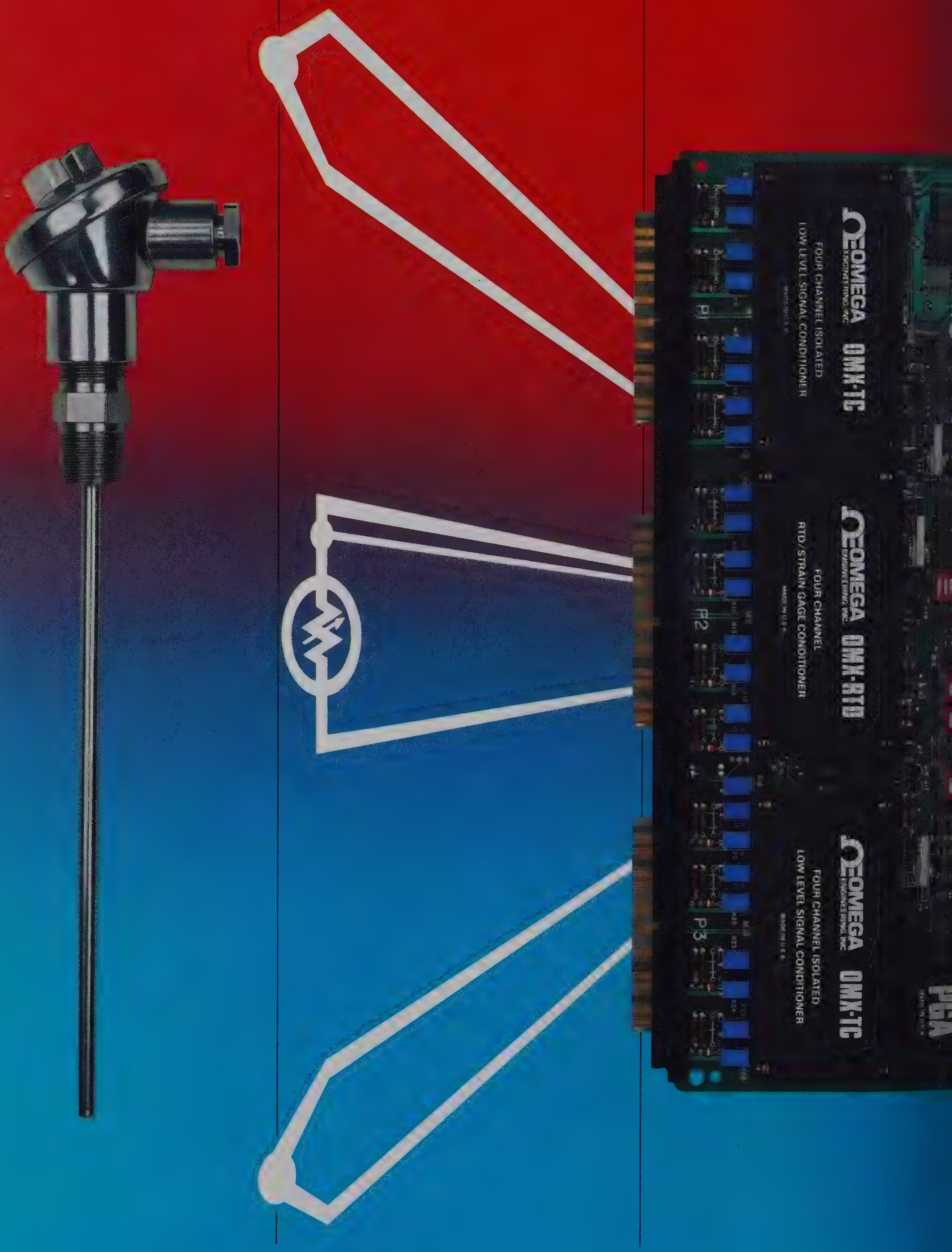
REAR PANEL

BASIC Language Computer

1. Can be easily programmed to perform mathematical operations and data manipulation.
2. Up to 85 sentences can be programmed to be spoken through the built-in speaker, through an external amplifier, or over the telephone.
3. The computer can respond to an incoming call and can also be programmed to place phone calls from a list of 85 numbers.
4. A clock in the SLC II keeps track of the time, date, and year; it even adds a day on leap year. This information can be spoken by the synthesizer.
5. Up to 32 key words or phrases can be recognized in data communications between computers or a computer and a terminal, or 16 contact closure type events can be sensed. These can be used to trigger actions and outputs. Custom responses to different situations are provided and not just an alarm.

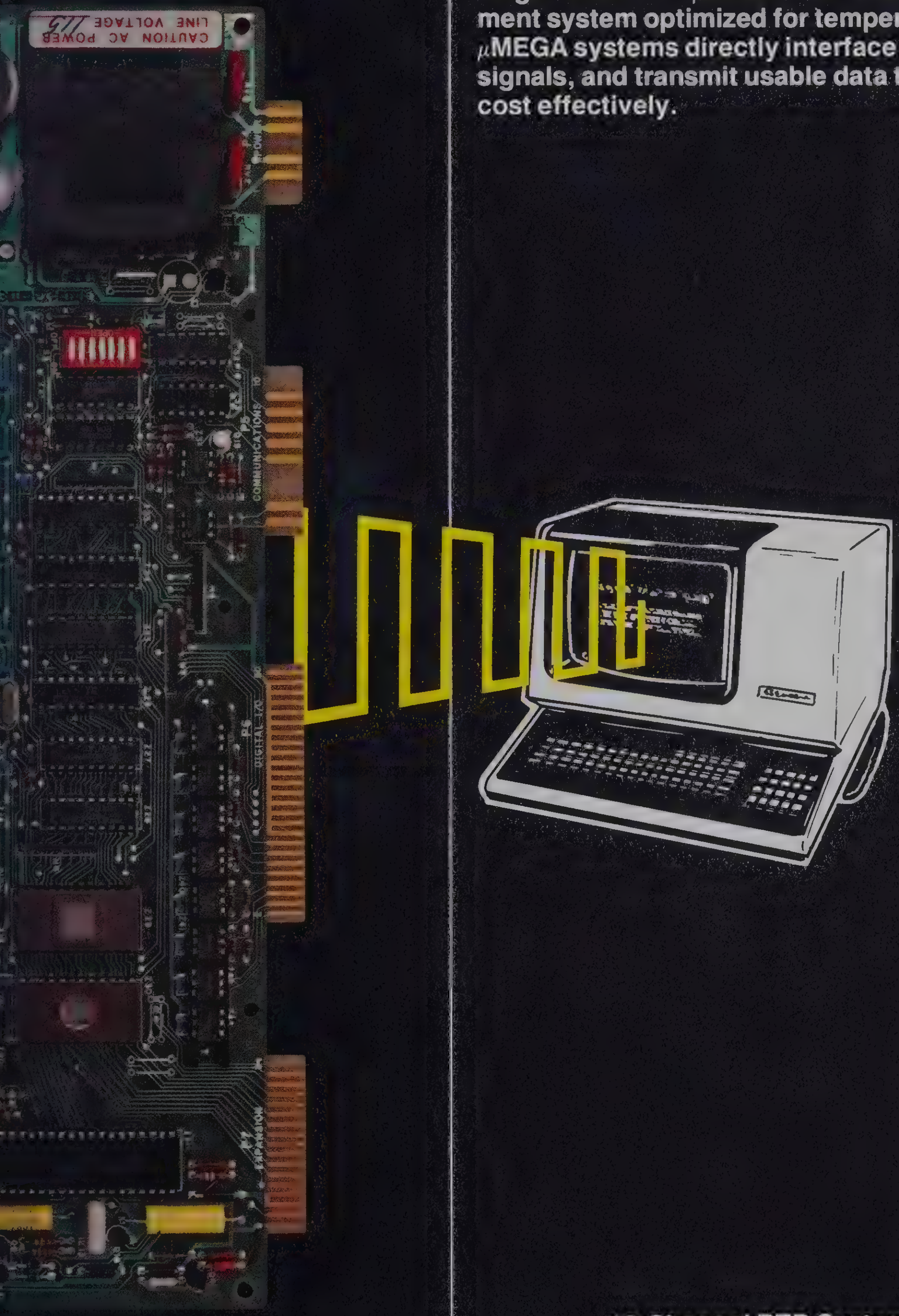
ORDER: **$3900**
SLC II

μMEGA™ 4000 SINGLE-BOARD


OMEGA ENGINEERING, INC.
OMX-TC
FOUR CHANNEL ISOLATED
LOW LEVEL SIGNAL CONDITIONER
MADE IN U.S.A.
P1
OMEGA ENGINEERING, INC.
OMX-RTD
FOUR CHANNEL
RTD/STRAIN GAGE CONDITIONER
MADE IN U.S.A.
P2
OMEGA ENGINEERING, INC.
OMX-TC
FOUR CHANNEL ISOLATED
LOW LEVEL SIGNAL CONDITIONER
MADE IN U.S.A.
P3
PGA

Measurement & Control System

Intelligent, expandable, direct data acquisition from process to computer.



AT LAST . . . A complete measurement and control system designed on a single board. It's μMEGA. The first low-cost, easy-to-use, easy-to-implement system optimized for temperature and low-level signal measurements. μMEGA systems directly interface to industrial transducers, process their signals, and transmit usable data to your computer or terminal, easily and cost effectively.

EASY INTERFACE OF T/C's, RTD's, and mV

- Serial Data Link
- Powerful Command Set
- Linearized Data In Engineering Units
- Digital I/O For Control

VERSATILE INPUTS

- Plug-In Conditioning Modules
- Input Function Switch Programmed
- Mixed Inputs in Groups of 4
- Thermocouples, RTD's and Low-Level Signals

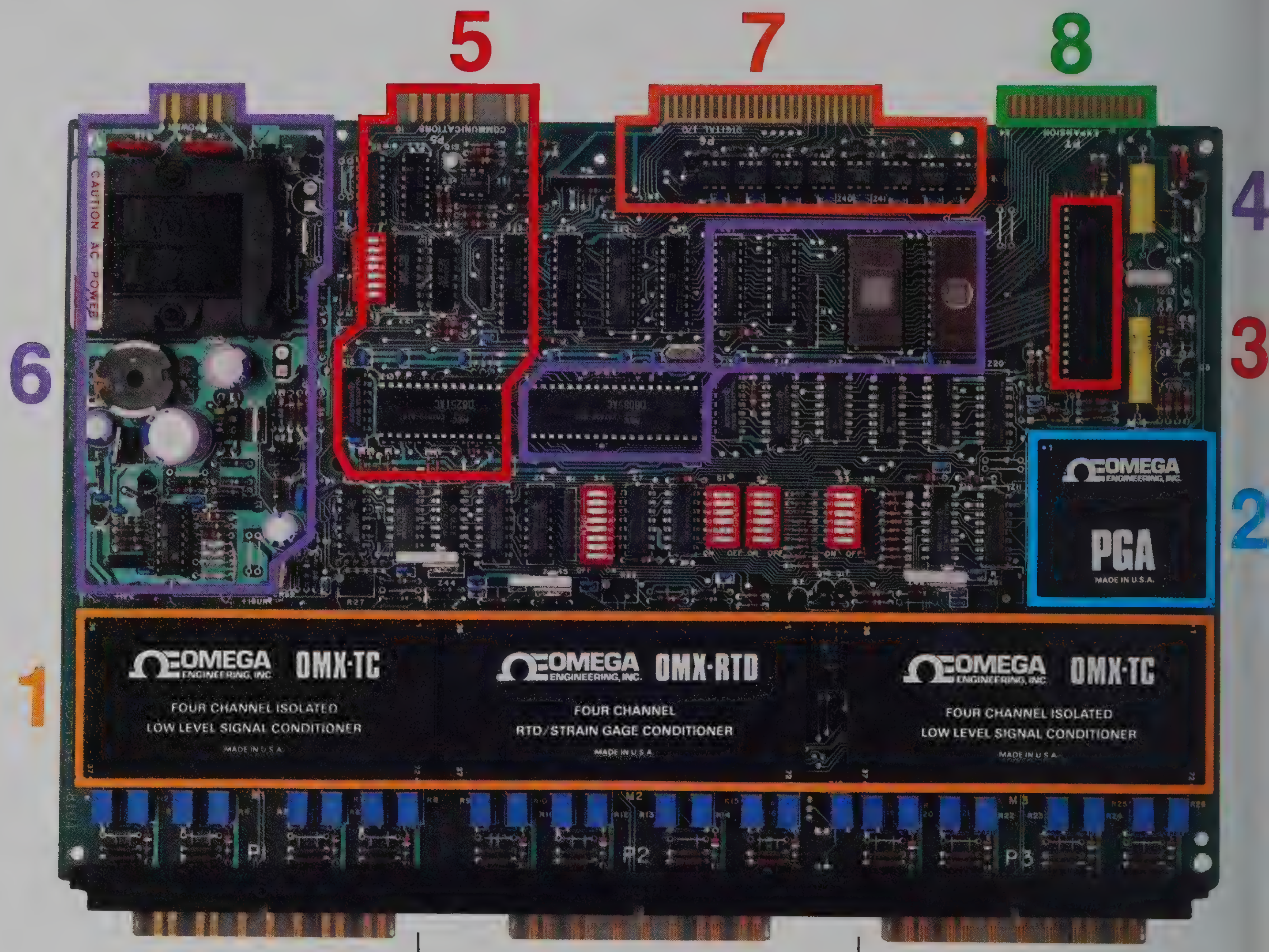
EXPANDABLE SYSTEMS

- On Site Expansion
- Main Board Up to 12 Channels
- Expander Board adds 12 Channels
- Multi-Clusters Up to 384 Channels Per Communications Bus

COST EFFECTIVE!

12 Channel RTD System	$1,897
12 Channel Thermocouple System	$2,167

A BETTER DATA ACQUISITION SYSTEM IN EVERY WAY!


5
7
8
6
4
3
2
1
OMEGA ENGINEERING, INC. PGA MADE IN U.S.A.
OMEGA ENGINEERING, INC. OMX-TC FOUR CHANNEL ISOLATED LOW LEVEL SIGNAL CONDITIONER MADE IN U.S.A.
OMEGA ENGINEERING, INC. OMX-RTD FOUR CHANNEL RTD/STRAIN GAGE CONDITIONER MADE IN U.S.A.
OMEGA ENGINEERING, INC. OMX-TC FOUR CHANNEL ISOLATED LOW LEVEL SIGNAL CONDITIONER MADE IN U.S.A.
CAUTION AC POWER

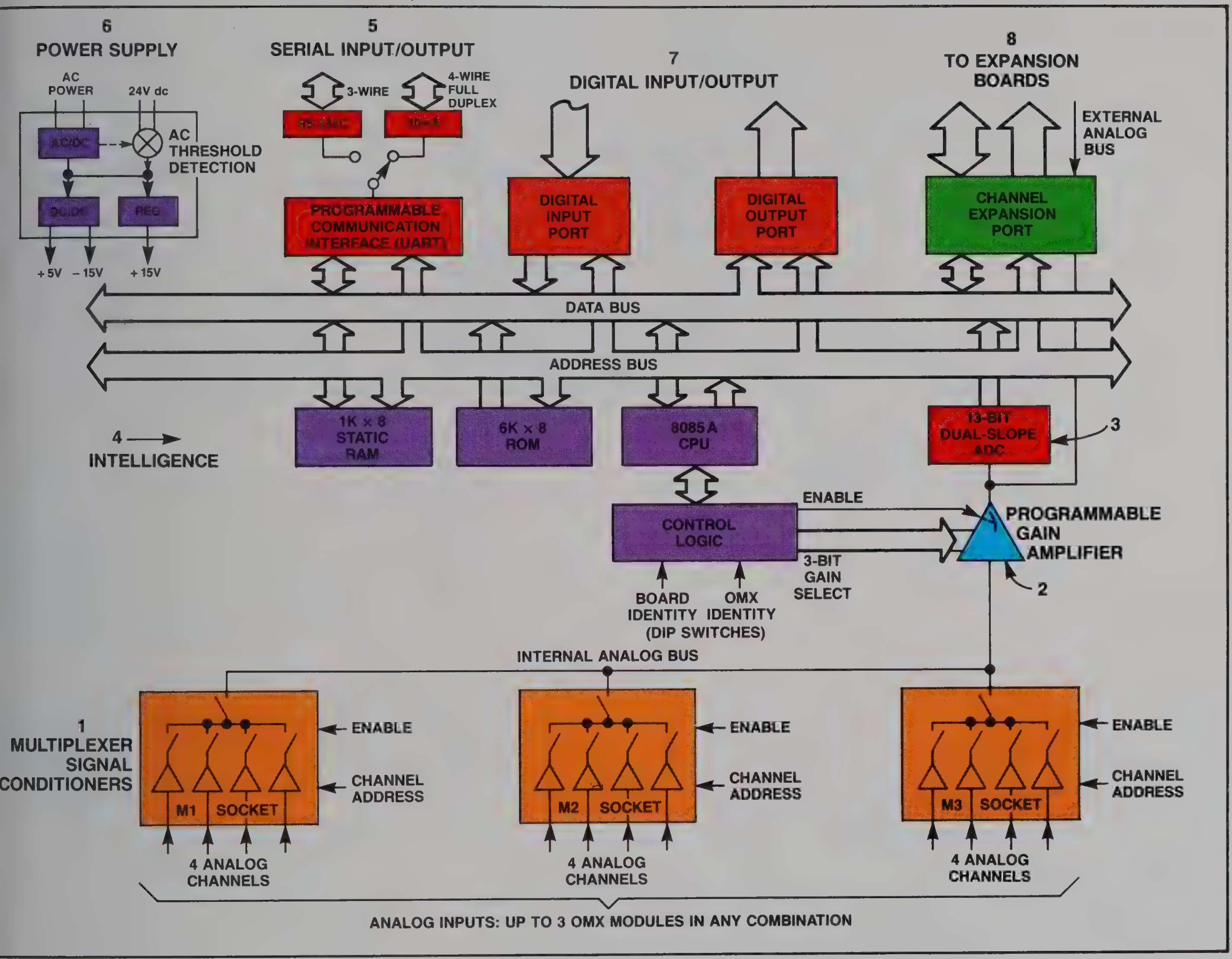
µMEGA™...
includes all of the functions necessary to scan your inputs and convert the signals into computer compatible engineering units. Just connect the sensors and computer to the µMEGA, add power and the system is in operation!

1. Multiplexed Signal Conditioner modules. Each OMX module accepts four channels of analog input and provides preamplification, scaling, multiplexing, and if necessary, isolation. Two module types and on-board dip switches permit a wide range of input sources to be accommodated, providing maximum flexibility in system configuration for thermocouples, RTD's, and general low level analog voltages.

2. Programmable Gain Amplifier (PGA). Gain of the PGA is automatically adjusted to match the input signal to the full scale range of the A/D converter to provide maximum accuracy without the need for user recalibration.

3. Analog to Digital Converter (A/D). An integrating 13 bit analog to digital converter (12 bits plus sign) con verts at either 15 or 30 channels per se cond with a normal mode rejection of 8 dB at 50/60 HERTZ to provide excellen performance in noisy environments.

4. Intelligence. A microcomputer with 6K of read-only memory and 1K of read-write memory provides supervisory control. The ROM contains firmware to control data acquisition functions, a look-up table for sensor linearization, and data format and com


6
POWER SUPPLY
AC POWER
24V dc
AC/DC
AC THRESHOLD DETECTION
DC/DC
REG
+5V
−15V
+15V
5
SERIAL INPUT/OUTPUT
3-WIRE
4-WIRE FULL DUPLEX
RS-232C
20mA
PROGRAMMABLE COMMUNICATION INTERFACE (UART)
7
DIGITAL INPUT/OUTPUT
DIGITAL INPUT PORT
DIGITAL OUTPUT PORT
8
TO EXPANSION BOARDS
EXTERNAL ANALOG BUS
CHANNEL EXPANSION PORT
DATA BUS
ADDRESS BUS
4
INTELLIGENCE
1K × 8 STATIC RAM
6K × 8 ROM
8085 A CPU
13-BIT DUAL-SLOPE ADC
3
ENABLE
CONTROL LOGIC
PROGRAMMABLE GAIN AMPLIFIER
3-BIT GAIN SELECT
2
BOARD IDENTITY
OMX IDENTITY
(DIP SWITCHES)
INTERNAL ANALOG BUS
1
MULTIPLEXER SIGNAL CONDITIONERS
M1 SOCKET
M2 SOCKET
M3 SOCKET
ENABLE
CHANNEL ADDRESS
ENABLE
CHANNEL ADDRESS
ENABLE
CHANNEL ADDRESS
4 ANALOG CHANNELS
4 ANALOG CHANNELS
4 ANALOG CHANNELS
ANALOG INPUTS: UP TO 3 OMX MODULES IN ANY COMBINATION

unication routines. This unburdens e host computer and allows dis- outed systems with a minimum of in- allation restrictions.

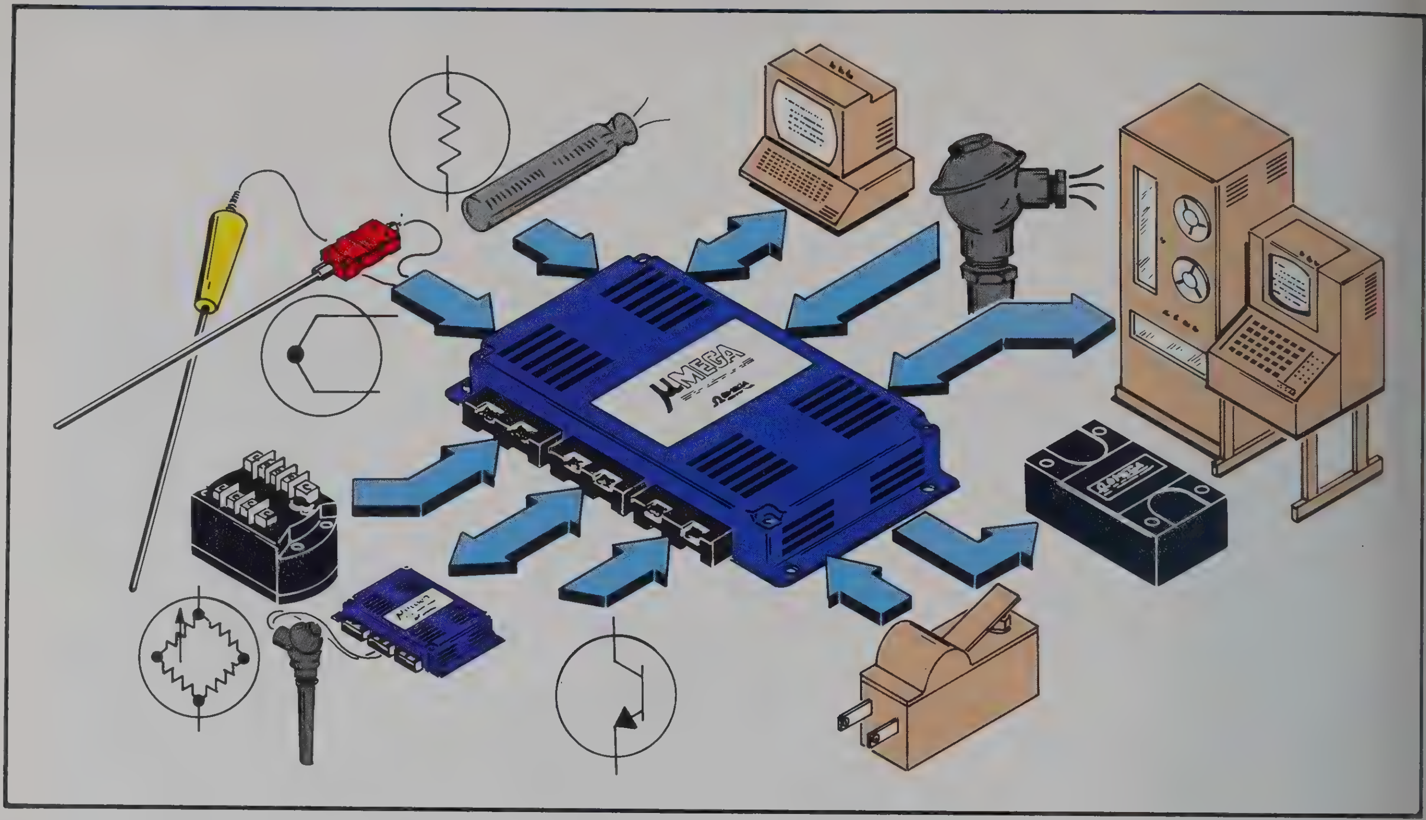
Serial Input-Output. The serial mmunications section contains a ART (universal asynchronous ceiver/transmitter), which provides ynchronous full duplex operation up 9600 baud. The μMEGA can be con- rted in the field to conform to your in- allation.

Power Supply. There are two wer supplies in this section—an ac/dc supply for ac line power and dc/dc supply to allow operation from plus 24 volts dc. The plus 24 dc input can be used for main or backup power using external batteries. Should a brown-out condition or ac power failure occur, the detector causes the supply to switch to dc input automatically.

7. Digital I/O. The eight inputs are optically isolated for 300 volts peak; they can sense contact closures or accept TTY logic levels. The eight outputs are latched TTL, capable of sinking up to 24 mA. This port can be used for remote switch sensing and control of OMEGA SSR relays without the necessity of using an additional computer port.

8. Expansion Port. The μMEGA 4000 can be expanded up to 48 analog input channels and 32/32 digital I/O channels by the addition of three μMEGA 4010 expander boards. The μMEGA 4010 permits low-cost channel expansion by sharing the system's A-D converter, microcomputer and serial communications circuitry located on the existing μMEGA 4000 master board.

SINGLE BOARD SYSTEMS



μMEGA™, THE LOW COST SOLUTION

to temperature data acquisition. You simply connect sensors directly to the system and all thermocouples are cold-junction compensated, RTD's are excited, noise is filtered and sensor response is linearized. A simple command from the host is all that is required to access the data in engineering units.

SIGNAL CONDITIONING

Two OMX input modules cover the full range of temperature measurement and small signal requirements. The OMX modules plug in to the μMEGA 4000 master board or the μMEGA 4010 expander board and include input protection, isolation (OMX-TC), filtering, amplification, and sensor excitation (OMX-RTD) for four channels. On-board programing switches allow the user to configure each OMX module for sensor type independently of other OMX modules so that mixed sensor systems can be accommodated without custom engineering. OMX-TC module is specifically designed to work with thermocouples. Each module can be programmed to accept Type J, K, T, or S thermocouples as well as linear signals up to 100 mV. Cold junction compensation is automatic when the OMX-1800 connector is used.

OMX-RTD module provides direct interface to 100 ohm platinum RTD's. Each module has selectable linearization for alpha = 0.00385 or 0.00392. The inputs are configured for 3-wire RTD sensors and the excitation current is supplied by the module.

MICROCOMPUTER

Built-in intelligence unburdens the host computer by allowing supervisory control. The microcomputer performs data acquisition control, linearization, conversion to engineering units, limit checking, interface control and data output formatting. The analog channels of the μMEGA 4000 are scanned continuously and the resulting data stored in the microcomputer's RAM. The data in RAM is refreshed on a continuous basis, thus, maintaining the latest data in memory so that requests for data from the host may be serviced immediately. Upon receipt of a transmit command, the microcomputer via the UART begins transmitting a string of data in ASCII format back to the host.

SERIAL COMMUNICATIONS

A full duplex UART is used to receive and transmit data at the serial I/O port. Jumper selectable for either RS-232C or 4-wire TTY 20mA current loop, this communications port offers asynchronous, full duplex operation. Even or odd parity and baud rates up to 9600 are selectable by switch settings to make the installation to an existing computer fast and easy.

DIGITAL I/O

Each μMEGA 4000 board has 8/8 digital I/O parts. The inputs are optically isolated for 300V peak and accept TTL logic levels or sense contact closures. The outputs are latched, TTL compatible, capable of sinking up to 24mA. Distributed control is available along with analog data acquisition.

HOW TO ORDER SINGLE-BOARD SYSTEMS

STANDARD SYSTEMS WITH CONDITIONING MODULES AND ANALOG INPUT CONNECTORS.

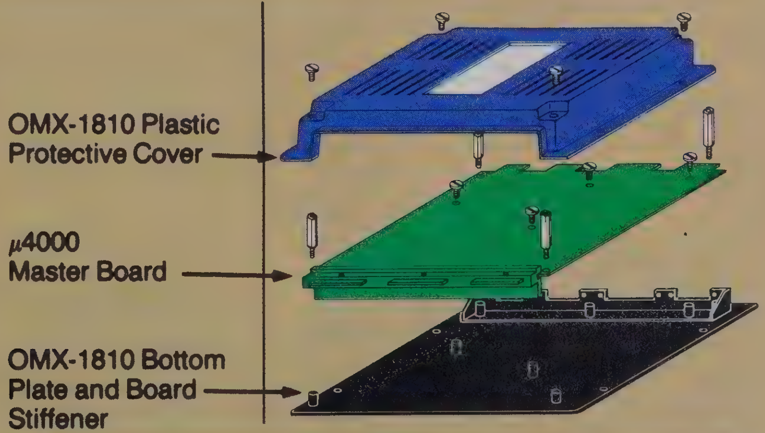
µMEGA – ☐ – ☐ – ☐ – ☐ – ☐

Channels 0-3 | Channels 4-7 | Channels 8-11

$1290	4000 = Master Board
	or
$ 990	4010 = Expander Board
	1 = 115 VAC
	or
	2 = 220 VAC
N/C	or
	3 = 100 VAC
	or
	4 = 240 VAC
N/C	xx = None
$ 288	TC = Thermocouple Conditioning Module with Analog Input Connector
$ 198	RTD = 100Pt Conditioning Module with Analog Input Connector

CONNECTORS

PART NO.	DESCRIPTION	PRICE
OMX 1800	Analog Input Connector (Supplied with Configured Boards)	**$28**
OMX 1802	AC/DC Power Connector with Solder Tabs	**6**
OMX 1802A	OMX 1802 with Pre-Wired 115 VAC Power Cord	**15**
OMX 1803	Communications Connector (For µMEGA 4000 only)	**7**
OMX 1804	Digital I/O Connector (If this feature is utilized)	**15**
OMX 1805	Expander Cable, 2 Ft. (Connects one µMEGA 4000 to one µMEGA 4010)	**34**


OMX-1810 Plastic Protective Cover
µ4000 Master Board
OMX-1810 Bottom Plate and Board Stiffener

SINGLE-BOARD ENCLOSURE OMX-1810

The OMX-1810 provides a convenient method of installation for a single µMEGA 4000 Master Board. A board stiffener and aluminum bottom plate assembly provide a sturdy mechanical support for the analog input connectors and circuitry. The plastic protective cover is removable to provide access to the conditioning logic.

$98

(Includes all hardware)

CLUSTER SYSTEMS

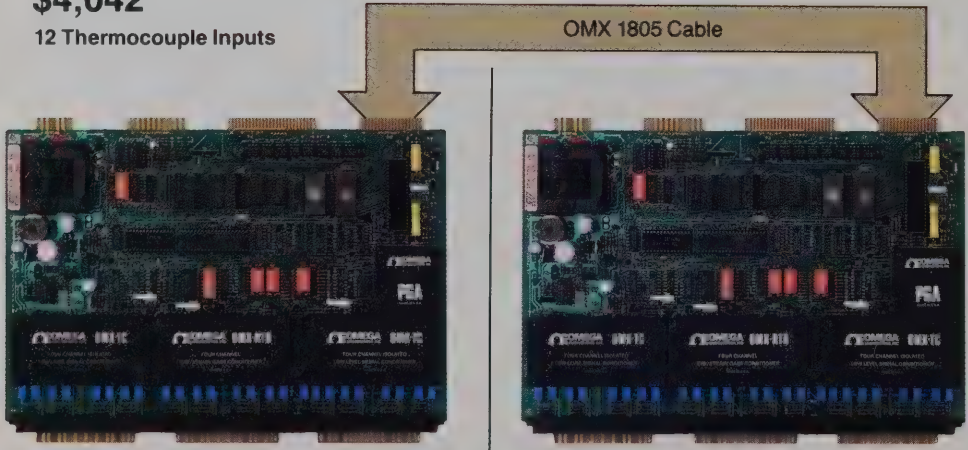
''Courtesy of Digital Equipment Corp

The μMEGA System EXPANDS to meet your needs! 48 Analog Channels $8,047

LOW COST 24-CHANNEL SYSTEM

$4,042

12 Thermocouple Inputs



The μMEGA 4010 expander board, like the master board, has 12 selectable analog channels (in groups of four) and 8/8 lines of digital I/O connected to a master board. Used with an OMX 1805 expander cable, a 24 channel analog input system is created that offers cost savings by sharing a common A/D converter, microcomputer, and serial communication on the master board.

POWERFUL CLUSTER SYSTEMS

The input capability of the μMEGA 4000 master board can be expanded by the addition of up to three μMEGA 4010 expander boards. Under the control of the microcomputer on the master board, the four board "cluster" has 48 analog inputs and 32/32 digital I/O channels.

In addition, up to eight clusters can be connected in a party line (serial) configuration to yield a total of 384 analog channels per computer port. This serial connection utilizes the 20ma, four wire current loop configuration. Substantial savings can be realized in wiring and cable cost at the expense of only communication speed over long distances.

OMX 1811 Card Cage $249

The OMX 1811 card cage has been designed to conveniently hold an interface cluster consisting of one μMEGA 4000 and up to three μMEGA 4010 expander boards. The left slot is reserved for the master board with all connections between it and the expander boards on a printed circuit backplane.

The power bus, expansion bus, and communication link are common. The analog inputs and digital I/O are connected directly to the boards.

HOW TO ORDER CLUSTER SYSTEMS

48 CHANNEL SYSTEM

With Thermocouple Inputs in a
Card Cage with all Connectors.

List Configured Boards *

ea. μMEGA 4000-1-TC-TC-TC	$2154
ea. μMEGA 4010-1-TC-TC-TC	5562

Add Enclosure

ea. OMX-1811	249

Select Connectors*

ea. OMX-1802A	15
ea. OMX-1803	7
ea. OMX-1804	60
Total	$8047

nalog Input Connectors are included
vith Configured Boards

COMPONENT PART LIST

MEGA 4000 Master Board	$1290
MEGA 4010 Expander Board	990
MX-TC Conditioning Module	260
MX-RTD Conditioning Module	170
MX-1800 Analog Input Connector	28
MX-1810 Single Board Enclosure	98
MX-1811 Four Board Card Cage	249
MX-1812 19″ Rack Adaptor For OMX-1811	29

Works with any
RS-232C or 20 mA
ASCII Port

For Your System ...

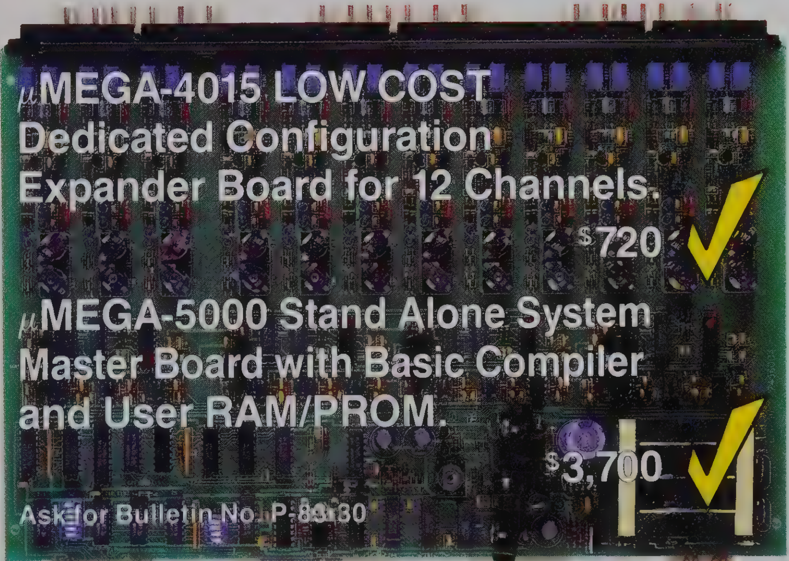
"Courtesy of IBM"

"Courtesy of Radio Shack, Division of Tandy Corp."

"Courtesy of Apple Computer Inc."

"Courtesy of Hewlett Packard, Personal Computer Division"

Coming Soon

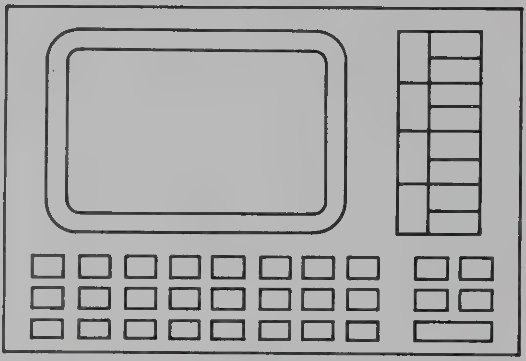

μMEGA-4015 LOW COST
Dedicated Configuration
Expander Board for 12 Channels.
$720 ✓

μMEGA-5000 Stand Alone System
Master Board with Basic Compiler
and User RAM/PROM.
$3,700 ✓

Ask for Bulletin No. P-83130

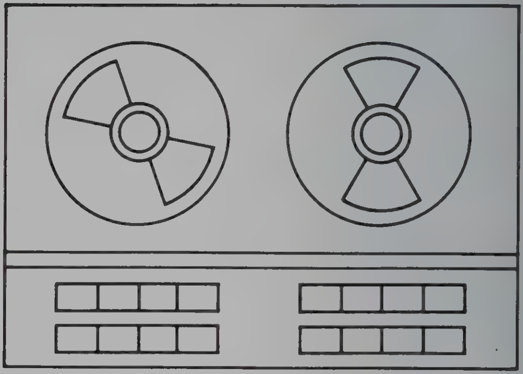
System Protocol

Terminal Mode



An easy-to-use mode for people. Three letter "English" commands put the power of the μMEGA at your fingertips.

Computer Mode



An easy-to-use mode for computers. The on-board intelligence does all the housekeeping, leaving the host computer free for other tasks.

Powerful Command Set

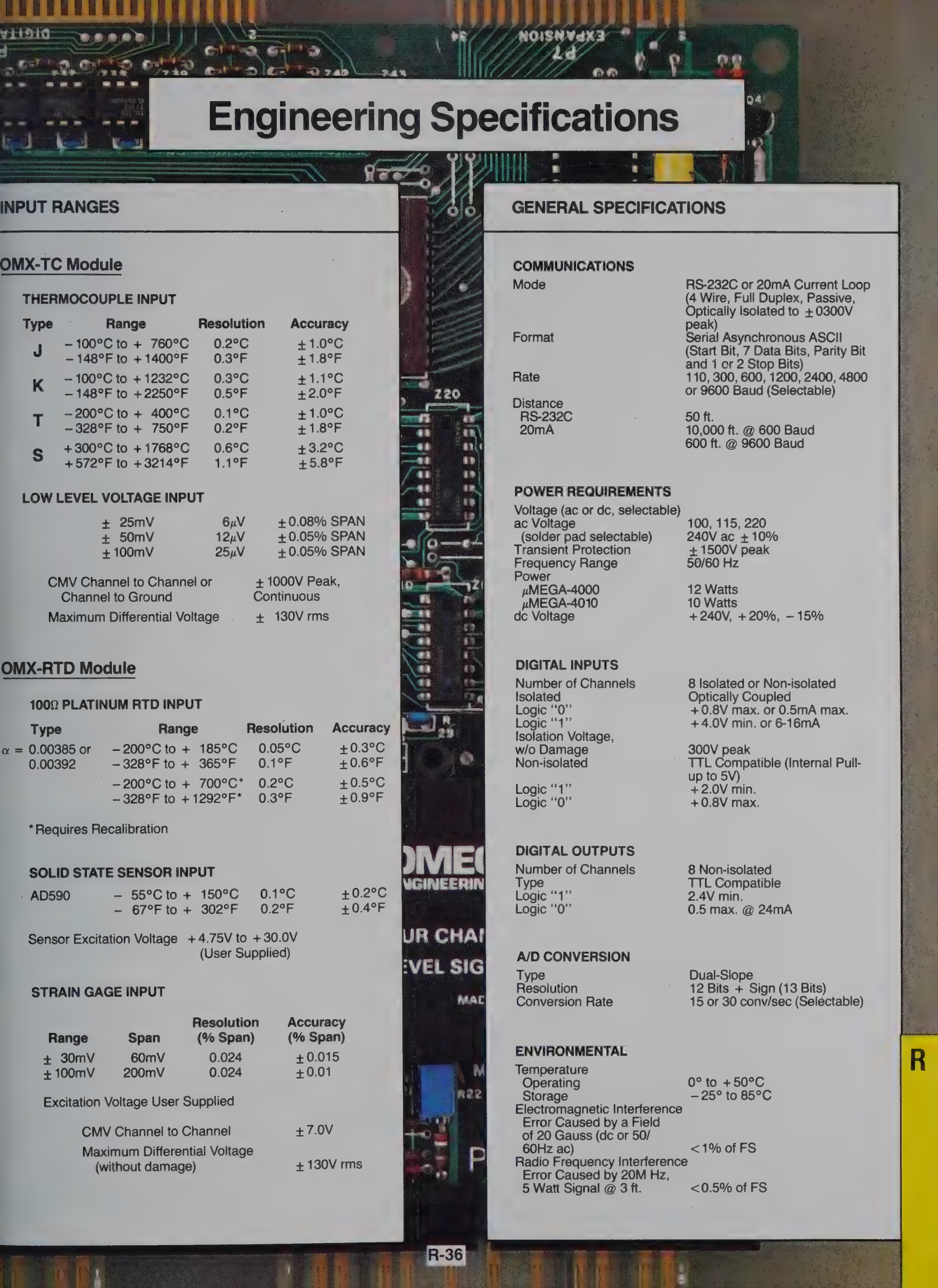
Limit Commands	Function
LIMIT n, LL, HL	Set "Hi" and "Low" Limits to channel n.
RESET	Clear "LIMIT EXCEEDED" bit in the status word.

Analog Data Commands	Function
CHANNEL n	Transmit channel n data.
SCAN n, m	Transmit channel n through channel m data.
FSCAN	Transmit data from channel set by ACTIVE command.
TEMP n	Transmit temperature of cold junction associated with channel n.

Protocol Modifying Commands	Function
FILL n	Add null characters in transmitted data to provide delay between carriage return and line feed.
DEGREE F	Transmit temperature data in degrees Fahrenheit.
DEGREE C	Transmit temperature data in degrees Celsius.

Task Supervision Commands	Function
RUN	Start continuous channel scanning routine.
HALT	Stop continuous channel scanning routine.
SKIP n	Skip channel n.
ACTIVE n, m	Continuously scan channels n through m inclusive.
STATUS	Transmit status word.

Digital I/O Commands	Function
SET p, b	Set digital output bit b on port p.
CLEAR p, b	Clear digital output bit b on port p.
TEST p, b	Read state of input or output bit b on port p.
DOUT p, d	Load the 8 output bits on port p to the value d where d represents two hexadecimal digits.
DIN p	Read state of the 8-bit data on port p expressed in two hexadecimal digits.



Engineering Specifications

INPUT RANGES

OMX-TC Module

THERMOCOUPLE INPUT

Type	Range	Resolution	Accuracy
J	−100°C to + 760°C −148°F to +1400°F	0.2°C 0.3°F	±1.0°C ±1.8°F
K	−100°C to +1232°C −148°F to +2250°F	0.3°C 0.5°F	±1.1°C ±2.0°F
T	−200°C to + 400°C −328°F to + 750°F	0.1°C 0.2°F	±1.0°C ±1.8°F
S	+300°C to +1768°C +572°F to +3214°F	0.6°C 1.1°F	±3.2°C ±5.8°F

LOW LEVEL VOLTAGE INPUT

± 25mV	6µV	±0.08% SPAN
± 50mV	12µV	±0.05% SPAN
±100mV	25µV	±0.05% SPAN

CMV Channel to Channel or Channel to Ground	±1000V Peak, Continuous
Maximum Differential Voltage	± 130V rms

OMX-RTD Module

100Ω PLATINUM RTD INPUT

Type	Range	Resolution	Accuracy
α = 0.00385 or 0.00392	−200°C to + 185°C −328°F to + 365°F	0.05°C 0.1°F	±0.3°C ±0.6°F
	−200°C to + 700°C* −328°F to +1292°F*	0.2°C 0.3°F	±0.5°C ±0.9°F

*Requires Recalibration

SOLID STATE SENSOR INPUT

AD590	− 55°C to + 150°C − 67°F to + 302°F	0.1°C 0.2°F	±0.2°C ±0.4°F

Sensor Excitation Voltage +4.75V to +30.0V (User Supplied)

STRAIN GAGE INPUT

Range	Span	Resolution (% Span)	Accuracy (% Span)
± 30mV	60mV	0.024	±0.015
±100mV	200mV	0.024	±0.01

Excitation Voltage User Supplied

CMV Channel to Channel	±7.0V
Maximum Differential Voltage (without damage)	±130V rms

GENERAL SPECIFICATIONS

COMMUNICATIONS

Mode	RS-232C or 20mA Current Loop (4 Wire, Full Duplex, Passive, Optically Isolated to ±0300V peak)
Format	Serial Asynchronous ASCII (Start Bit, 7 Data Bits, Parity Bit and 1 or 2 Stop Bits)
Rate	110, 300, 600, 1200, 2400, 4800 or 9600 Baud (Selectable)
Distance	
RS-232C	50 ft.
20mA	10,000 ft. @ 600 Baud 600 ft. @ 9600 Baud

POWER REQUIREMENTS

Voltage (ac or dc, selectable)	
ac Voltage	100, 115, 220
(solder pad selectable)	240V ac ±10%
Transient Protection	±1500V peak
Frequency Range	50/60 Hz
Power	
µMEGA-4000	12 Watts
µMEGA-4010	10 Watts
dc Voltage	+240V, +20%, −15%

DIGITAL INPUTS

Number of Channels	8 Isolated or Non-isolated
Isolated	Optically Coupled
Logic "0"	+0.8V max. or 0.5mA max.
Logic "1"	+4.0V min. or 6-16mA
Isolation Voltage, w/o Damage	300V peak
Non-isolated	TTL Compatible (Internal Pull-up to 5V)
Logic "1"	+2.0V min.
Logic "0"	+0.8V max.

DIGITAL OUTPUTS

Number of Channels	8 Non-isolated
Type	TTL Compatible
Logic "1"	2.4V min.
Logic "0"	0.5 max. @ 24mA

A/D CONVERSION

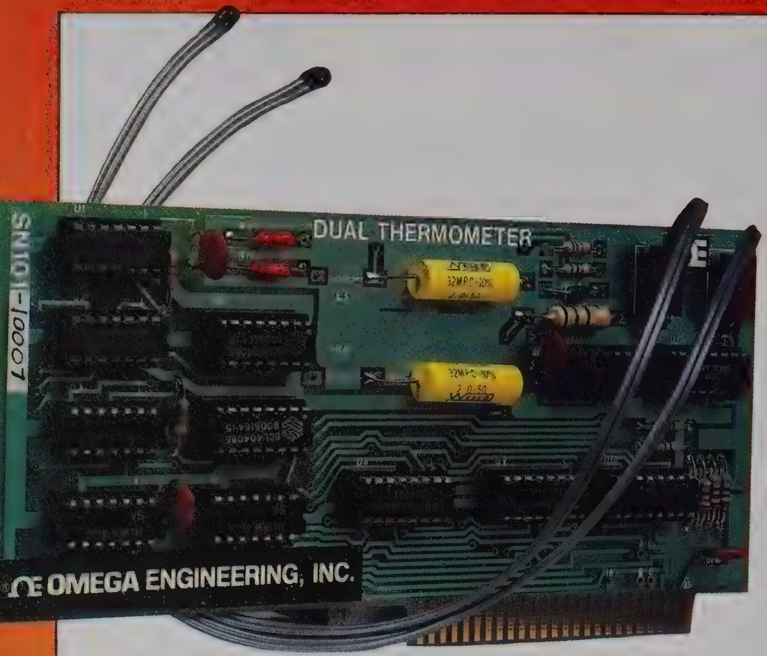
Type	Dual-Slope
Resolution	12 Bits + Sign (13 Bits)
Conversion Rate	15 or 30 conv/sec (Selectable)

ENVIRONMENTAL

Temperature	
Operating	0° to +50°C
Storage	−25° to 85°C
Electromagnetic Interference Error Caused by a Field of 20 Gauss (dc or 50/60Hz ac)	<1% of FS
Radio Frequency Interference Error Caused by 20M Hz, 5 Watt Signal @ 3 ft.	<0.5% of FS

ACQUISITION AND MICROCOMPUTER GLOSSARY

(Continued from page R-4)



I

INTERFACE—The means by which two systems or a system and a peripheral are connected and interact with each other.

INTERPRETER—A program that converts each instruction in a high level language program into machine code as it runs—much slower than an assembled program.

K

KEYBOARD—The set of keys found on a terminal for the entering of characters into the computer.

KBYTE (KB)—1,024 bytes.

L

LARGE SCALE INTEGRATION (LSI)—The combining of about 1,000 to 10,000 circuits on a single chip. Typical examples of LSI circuits are memory chips, microprocessors, calculator chips, and watch chips.

LETTER QUALITY PRINTER—The printer used to produce final copies of documents. It produces typing comparable in quality to that of a typewriter.

M

MACHINE LANGUAGE—Instructions that are written in binary form that a computer can execute directly. Also called object code and object language.

MAGNETIC TAPE (Magtape)—A magnetic storage media for permanent storage of computer data on reels of tape similar to that on a stereo system.

MASS STORAGE—A device like a disk or magtape that can store large amounts of data readily accessible to the central processing unit.

MBYTE (MB)—Mega-byte or one million bytes.

MICROCOMPUTER—A computer which is physically very small—it can fit on or under a desk—and which is based on large scale integration (LSI) circuitry. It is usually the least expensive of the computer types.

MINICOMPUTER—A computer smaller in size than a mainframe computer but larger than a micro.

MODEM—Acronym for MOdulator/DEModulator. A device that transforms digital signals into audio tones for transmission over telephone lines, and does the reverse for reception.

MOTHERBOARD—In a multi-board system, the board that contains the bus lines and edge connectors to accommodate the other boards in the system.

N

NETWORK—A group of computers that are connected to each other by communications lines to share information and resources.

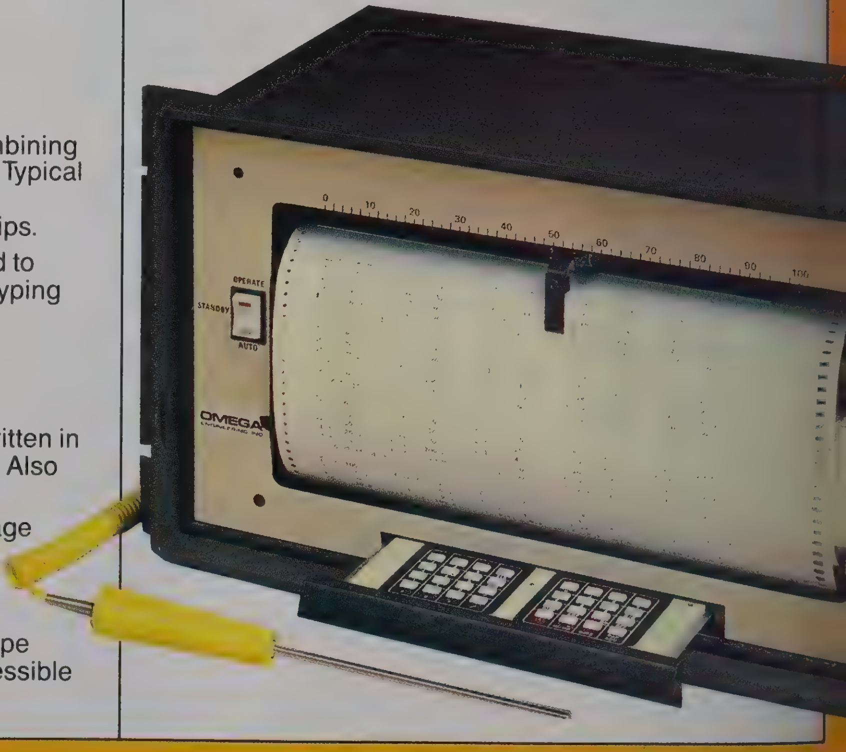
NIBBLE—One half of a byte (usually four bits).

O

OPERATING SYSTEM—A collection of computer programs that controls the overall operation of a computer and performs such tasks as assigning places in memory to programs and data, processing interrupts, scheduling jobs, and controlling the overall input/output of the system.

P

PARALLEL TRANSMISSION—Sending all data bits simultaneously; one wire is needed for each bit. See serial transmission.



WB-31
WHITE BOX
OMEGA
ANALOG/RS-232C INTERFACE
OMEGA

PARITY—A one-extra-bit code used to detect recording or transmission errors by making the total number of "1" bits in a unit of data—including the parity bit itself—odd or even.

PERIPHERAL—A device that is external to the CPU and main memory, e.g., printer, modem, or terminal, but connected to it by appropriate electrical connections.

PIXELS (picture elements)—Definable locations on a display screen that are used to form images on the screen. For graphics displays, screens with more pixels generally provide higher resolution.

PORT—A signal input (access) or output (egress) point on a computer.

PROGRAM—A list of instructions that a computer follows to perform a task.

PROM—Acronym for Programmable Read Only Memory. A semiconductor memory whose contents cannot be changed by the computer after it has been programmed.

PROTOCOL—A formal definition that describes how data is to be exchanged.

R

RAM—Acronym for Random Access Memory. A semiconductor memory that can be both read and changed during computer operation. Unlike other semiconductor memories, this one is volatile— if power to the RAM is cut off for any reason, all data stored in the device is lost.

REMOTE—Not hard-wired; communicating via switched lines such as telephone lines. Usually refers to peripheral devices (e.g., printers, video terminals) that are located at a site away from the CPU.

RESOLUTION—The smallest detectable increment of measurement. Resolution is usually limited by the number of bits used to quantize the input signal; a 12-bit A/D can resolve to one part in 4096 ($2^{12} = 4096$) See Accuracy.

REVERSE VIDEO—A feature on a display unit that produces the opposite combination of characters and background from that which is usually employed, i.e., black characters on a white screen if having white characters on a black screen is normal.

ROM—Acronym for Read Only Memory. A semiconductor memory containing fixed data—the computer can read the data but cannot change it in any way.

S

SERIAL TRANSMISSION—Sending one bit at a time on a single transmission line. Compare with parallel transmission.

SOFTWARE—Generally, programs loaded into a computer from external mass storage but also extended to include operating systems and documentation.

SOURCE CODE—A non-executable program written in a high-level language. A compiler or assembler must translate the source code into object code (machine language) that the computer can understand.

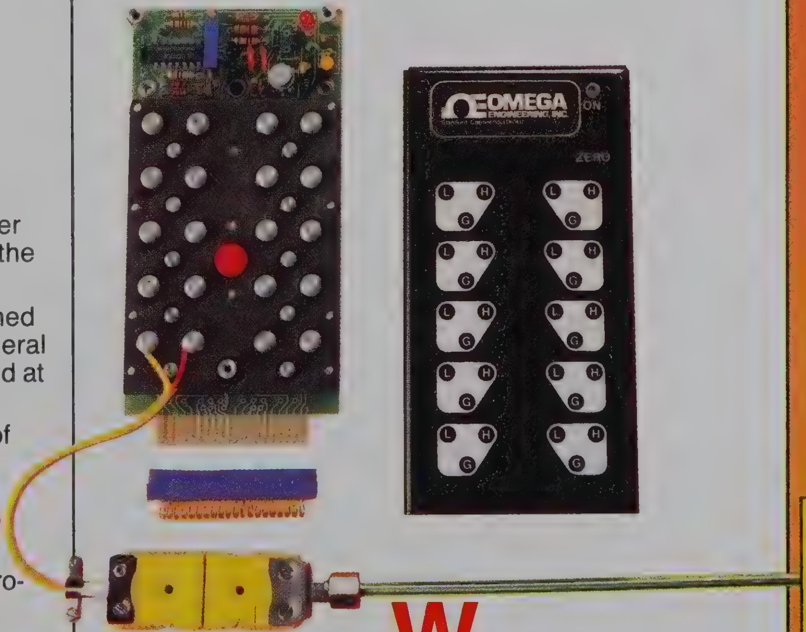
T

TAPE—A recording media for data or computer programs. Tape can be in permanent form, such as perforated paper tape. Generally, tape is used as a mass storage medium, in magnetic form, and has a far higher storage capacity than disk storage, but it takes much longer to write or recover data from tape than from a disk.

TERMINAL—An input/output device used to enter data into a computer and record the output. Terminals are divided into two categories: hard copy (e.g., printers) and soft copy (e.g., video terminals).

TRANSDUCER—A device which converts something measureable into another form (often, a physical property such as temperature, flow, etc., into an electrical signal usually at a low level); frequently used interchangeably with "sensor."

TRANSMITTER—A device which translates the low-level output of a sensor or transducer to a higher level signal suitable for transmission to a site where it can be further processed.



W

WORD—Number of bits treated as a single unit by the CPU. In an eight-bit machine, the word length is eight bits; in a sixteen-bit machine, it is sixteen bits.

WRITE—To put information into a storage device.

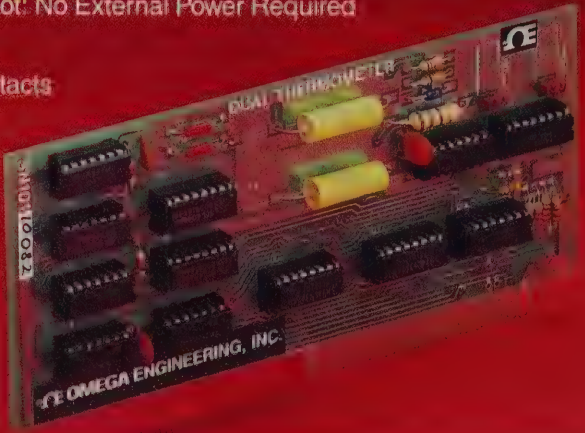
PLUG TEMPERATURE INTO

OMEGA® WHITE BOX™ PRODUCTS

THE BOARD

- Use Any Card Slot: No External Power Required
- Dual Input
- Fully Socketed
- Gold Plated Contacts
- Self Calibrating

Completely
Assembled—
Just Plug it in!



THE SOFTWARE —*Included*

- Complete OMEGASOFT™ Instruction Manual
- Measure, Alarm, Record, and Output Automatically with an easy to use prompted program
- 16 Sector Disk

OWNER'S MANUAL
OMEGA
for Apple
OMEGASOFT
OMEGASOFT
Thermistors

THE PROBES —*Included*

- Two ON-902-44008 SMP Standard
- Differential Measurements
- 10 Foot Extension Leads Supplied
- Many Other Styles Available
- Precision 30kΩ ntc Thermistor Element

- Use one or two probes for temperature measurement
- Monitor maximum and minimum temperatures of both probes
- Set alarms for temperatures above and below the preset maximum and minimums
- Record the difference between the two thermometers
- Specify output in Fahrenheit, Celsius, or Kelvin (absolute)
- Record data at predefined intervals on a printer or disk
- Four Digital outputs for alarm or control

Specifications:

Accuracy: ±0.4°C from −20 to 50°C (−4° to 122°F).
±1.0°C from −50° to −20°C and 50°C to 100°C (−58° to −4°F and 122° to 212°F).
Repeatability: ±0.1°C
Usable range: −55° to 150°C.
(The probes supplied are limited to 125°C.)

Up to 500 feet of AWG #18 cable may be added to extend the probes with no loss in accuracy.

All probes, including replacements, are interchangeable with no loss of accuracy.

A timer on the card is used by the software to generate a 50 year clock. (No battery backup.)

® Apple and Applesoft are registered trademarks of APPLE COMPUTER INC.

YOUR APPLE OR IBM PC

The Dual Thermometer Card plugs into any peripheral slot; up to seven cards can be used simultaneously. The program runs on any Apple II with 48K RAM, Applesoft™ BASIC, and at least one disk drive. The program is written in Applesoft BASIC so you can customize it easily.

0 CLOCK DISPLAY OFF 12 HR 24 HR
1 TEMPERATURE DEGREES F C K
2 DATALOGGING OFF DISK PRINTER
3 PROBE #1
4 DISPLAY OFF ON
5 MAX/MIN/ALARM DISPLAY OFF ON
6 AUTO MAX/MIN RESET OFF ON
7
8 HIGH ALARM OFF
9 LOW ALARM OFF
N SETUP NEXT PROBE
DUAL THERMOMETER
OMEGA ENGINEERING, INC
OMEGA ENGINEERING, INC
disk II
OMEGASOFT

Dimensions:
2¾″ × 6½″

Plugs Into Any Slot

Comprehensive Display

Up to 7 Boards in 1 Apple

Software Included

Easy Connection Adaptor Included

Includes:

- Card
- Probes Extensions
- Software
- Manual
- Jack Panel

HOW TO ORDER.

For Apple II Series
Model WB-DTK-A

For IBM-PC*
Model WB-DTK-I

$260

R

IBM is a registered
trademark of Internat
Business Machines, Inc

NEW!

THERMOCOUPLE INPUT

A White Box™ Solution To Your Temperature Acquisition Application Using Thermocouples.

Model WB-TCK-A for APPLE II, II PLUS, or IIe

- Software Linearization
- Eight Inputs
- Compensated Connection
- Plug-in And Run
- Thermocouples, Voltage and Current

Complete Thermocouple Scanning System For Apple
WB-TCK-A

$585 ✓

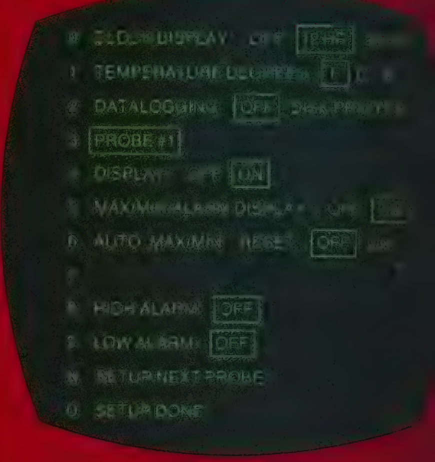
Scanner Card Alone Without Cold Junction Board For Apple
WB-MVK-A

$490 ✓

Interactive Interface with

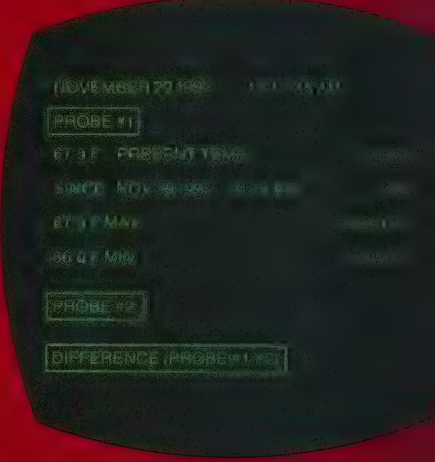
Setup

The program is in two parts, both written in BASIC for Apple or IBM PC's. The first part is the setup. The second part is the display of the time and temperature. When you boot the disk you will always be placed in the setup mode. Here you can set the time on the clock or customize the temperature display. When you have specified a setup that you will use again, you can save it on the disk. The setup file can be read back into memory to bring back the same setup at another time. When the setup is done, you may go to the display mode. In this mode the time and temperature are displayed on the screen.



Display

Tailor the display on the screen to your needs. With one card you can see time, temperature, maximum and minimum temperatures, and alarm information for two probes. It also displays the temperature difference between the probes. The software will support up to 7 Dual Thermometer cards with 14 probes. You can setup the screen just the way you want, to make important data easily visible. For each probe, display only the data you want plus choices like: temperature in degrees Fahrenheit, Celsius, or Kelvin; and display a 12 or 24 hour clock. You may store data on the disk or print at any interval you choose, from seconds to once a year.



Monitor

The temperature updates every few seconds. This is done using interrupts, so it will continue even if you exit and run another program. When you run the Dual Thermometer program again, the time will still be correct and the maximum and minimum temperatures will have been updated while you were "away."

Manage

There is no display unless the Dual Thermometer program is running. If an alarm condition occurs while running another program, the alarm will beep. To see what probe is giving the alarm, just run the Dual Thermometer program. If you have a large number of probes, you can setup the display to show only the pertinent information, or you can scroll the screen through a display that is larger than the screen. The display format can easily be modified without losing any data.

High Level Output

Requirements:

- Apple II plus or Apple II standard.
- 48K RAM with DOS 3.3
- At least one disk drive
- Applesoft in ROM or RAM
- A printer is optional
- A separate clock card may be used instead of the on board timer, the time display is the same.

Software Supported Expansion! Add One Multiplexer or One Output Control to Your System. Multiplexers Cannot Be Used When an Output Module is Installed.

OMEGA ENGINEERING, INC.

Expander I/O Card

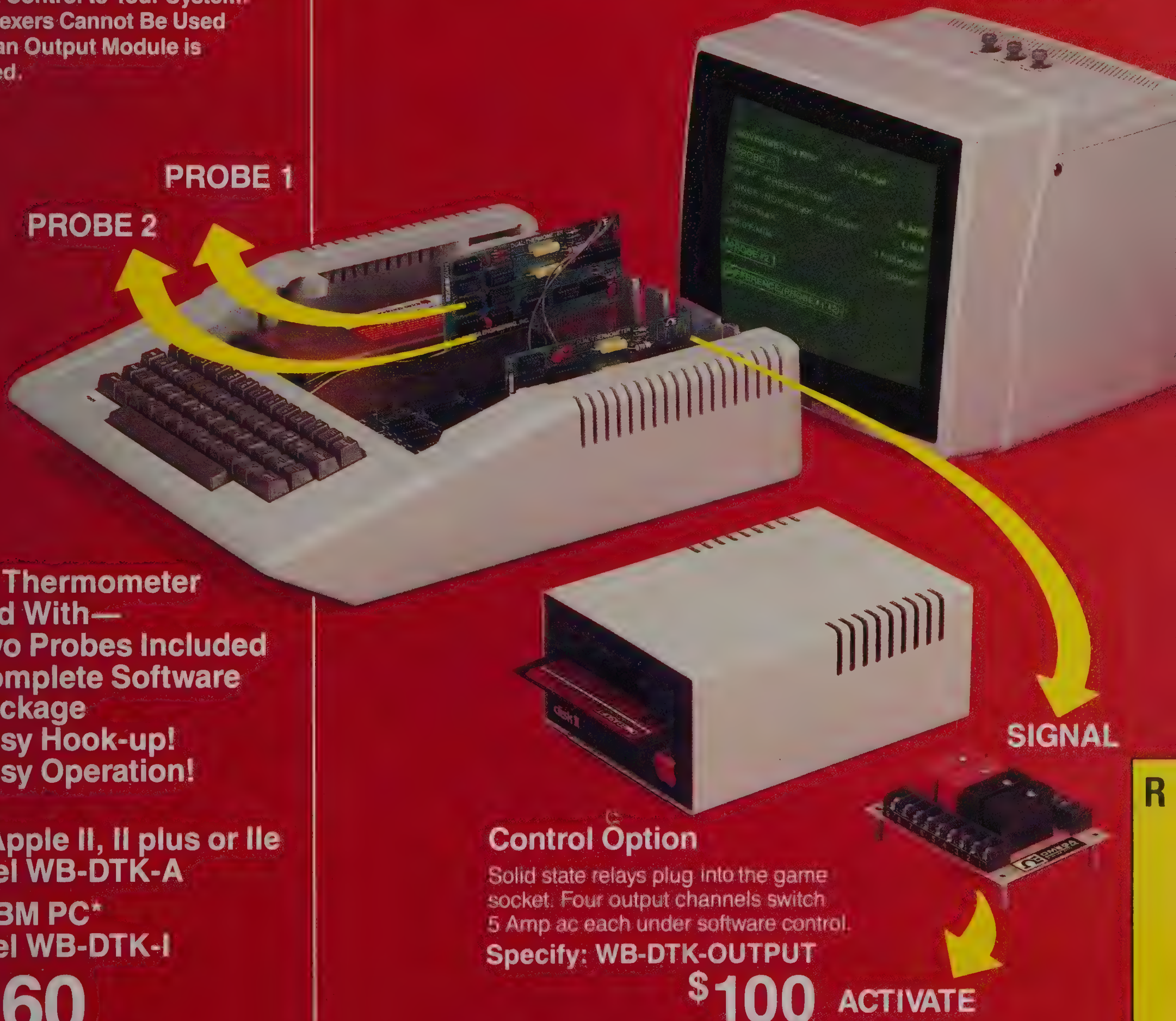
Multiplex eight probes into a single channel or provide up to eight low level relay contact outputs.

Specify: WB-DTK-I/O

If input scanning only is selected, two expanders can be used with each scanner card.

$330

FOR APPLE ONLY



Dual Thermometer Board With—

- **Two Probes Included**
- **Complete Software Package**
- **Easy Hook-up!**
- **Easy Operation!**

For Apple II, II plus or IIe Model WB-DTK-A

For IBM PC* Model WB-DTK-I

$260

*Available Late 1983

Control Option

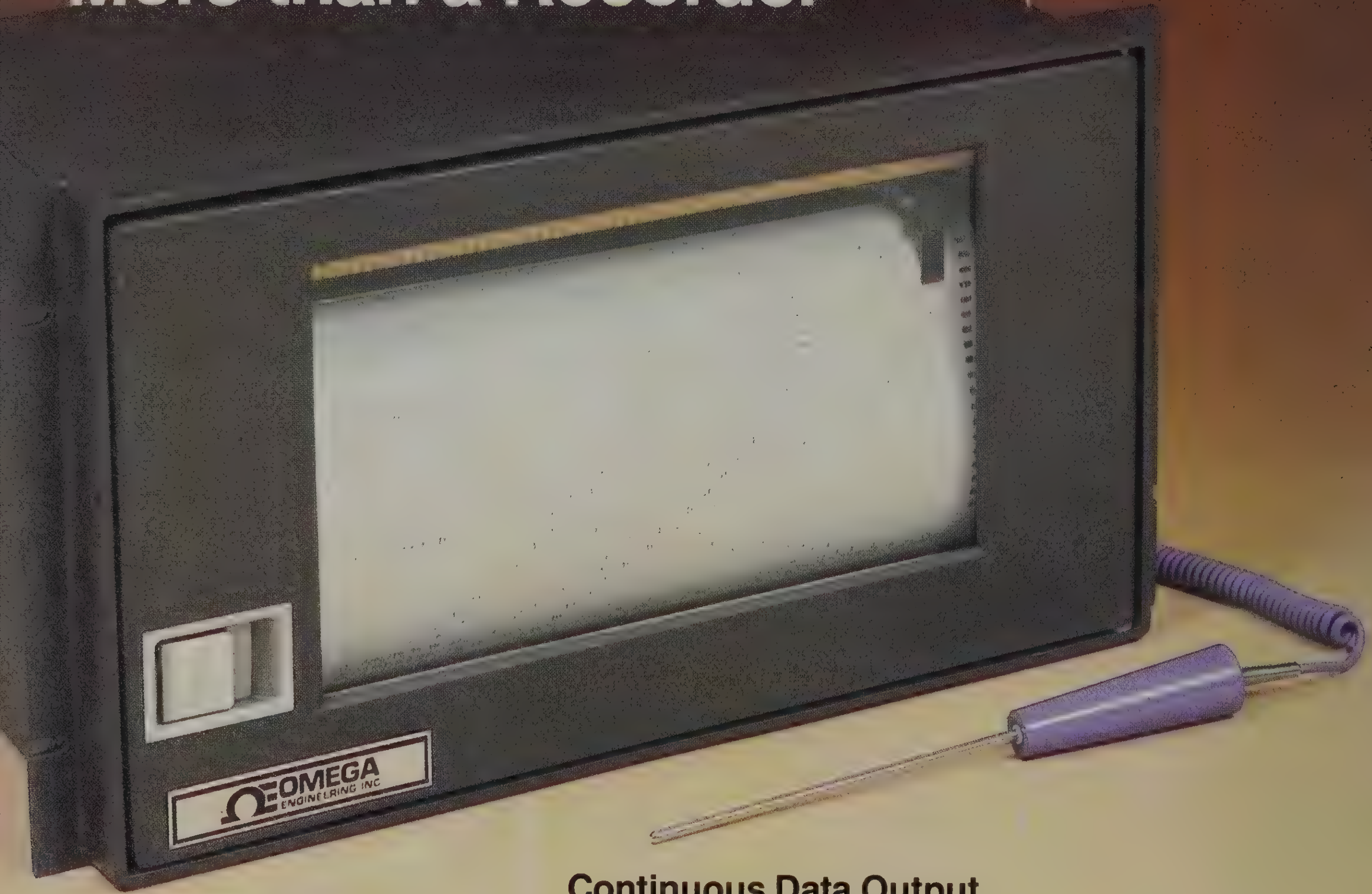
Solid state relays plug into the game socket. Four output channels switch 5 Amp ac each under software control.

Specify: WB-DTK-OUTPUT

$100

FOR APPLE ONLY

The Series OM-270
More than a Recorder



Continuous Data Output on Passive ASCII Port.

Model OM-270
$3,450

OM-270 FEATURES

- Microprocessor Controll
- 32 Channel Trend Recording
- Thermocouple Input— J, K, T, E, R, S and N
- Automatic Self-calibratio
- Operator Selectable Ranges
- Real Time Clock
- Alarms—High and Low o Each Channel
- Continuous Serial ASCII Data Output
- Thermal Printing

32 Programmable Channels

The OM-270 and OM-271 recorders meet most process and laboratory applications by utilizing the versatility in signal conditioning that only a microprocessor can provide. Each channel can be individually programmed for range and sensor type without the need for range cards or special hardware. The parameters of any channel may be changed at any time by a command from the keyboard. Cold junction compensation and linearization are included for thermocouples as well as linear voltage scales for other types of sensors. Connection of all 32 channels is accomplished at an isothermal terminal strip at the rear of the instrument.

The design gives the user optimum performance in a dependable and serviceable package. To maximize reliability, mechanical parts have been kept to a minimum; only the chart drive and thermal print head assembly contain moving parts.

Records Trends
Records Data
OPERATE
STANDBY
AUTO
OMEGA
ENGINEERING, INC.

Remote Programming Standard!

OM-271 Includes All of the OM-270 Features PLUS:

- **Data Log Mode**
- **Conditioning for B, C, G, D and Platinel II Thermocouples**
- **100Ω Platinum RTDs $\alpha =$ .00385 and .003923**
- **Δ T Mode**
- **Alarm Mode Chart and Print Rates**
- **Keyboard Lockout Password**
- **Remote ASCII Programming**
- **°F or °C Readout**

Model OM-271
$4,100

Trend or Data Display

Both models record the trend of every selected channel in under 2 second cycles. In addition, the Model OM-271 can be converted into a data logger either from the keyboard or remotely. In this mode, the input signals are digitized and printed in a five column format across the chart. A printout of all 32 channels takes approximately 60 seconds and includes the date and time. Print frequency can be programmed from once each minute to once every 5000 minutes.

All 32 channels are scanned every 2 seconds and compared to the stored alarm values. When an alarm is detected, either the high or low alarm relay is immediately activated. During every scan cycle, the internal reference source is used to check both zero and full scale values and make calibration adjustments automatically if needed.

For Complete Details See Page N-3 in the COMPLETE TEMPERATURE MEASUREMENT HANDBOOK AND ENCYCLOPEDIA™

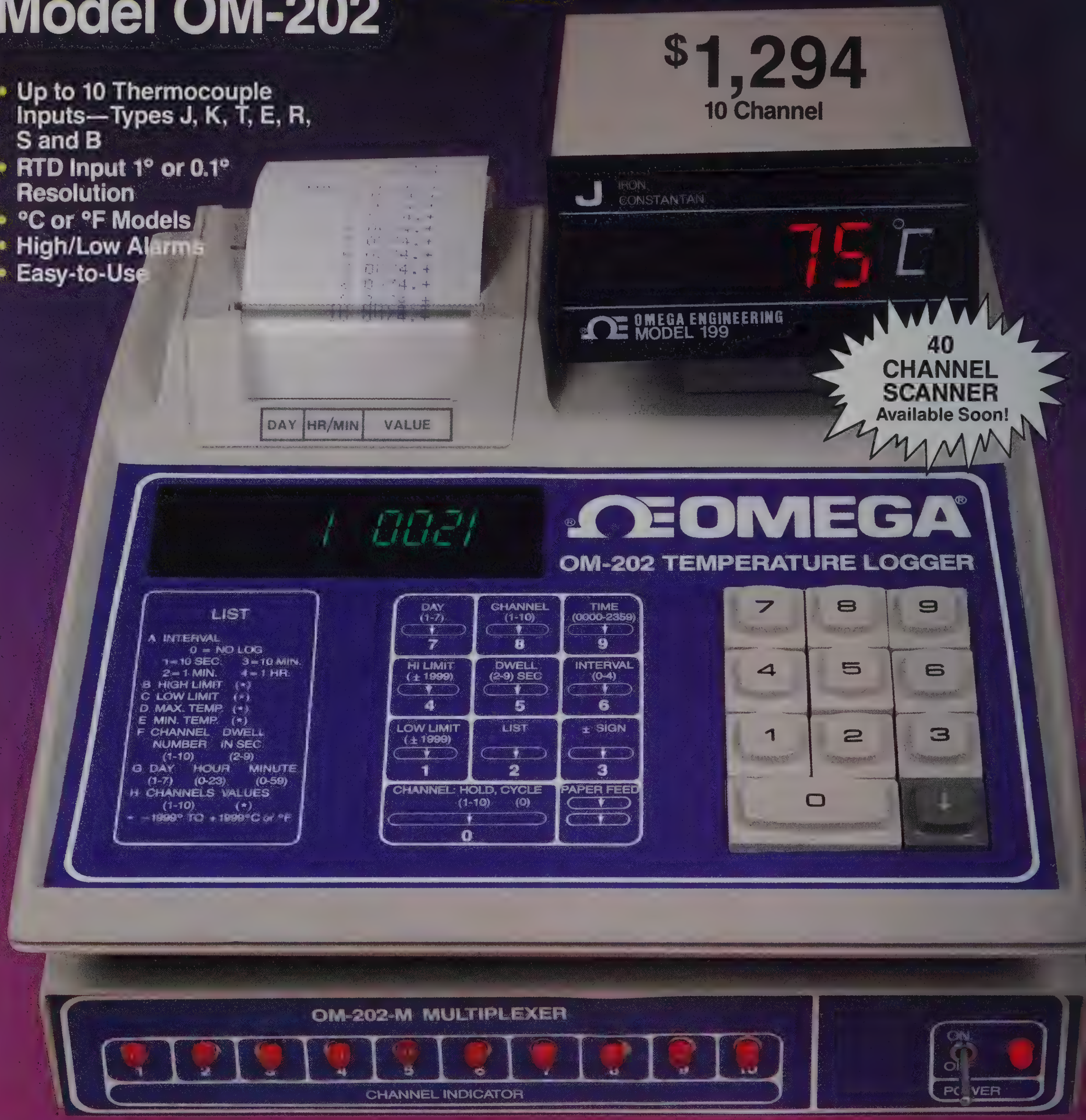
Temperature Logger

Model OM-202

- Up to 10 Thermocouple Inputs—Types J, K, T, E, R, S and B
- RTD Input 1° or 0.1° Resolution
- °C or °F Models
- High/Low Alarms
- Easy-to-Use

$1,294
10 Channel

40 CHANNEL SCANNER Available Soon!


J IRON CONSTANTAN
75 °C
OMEGA ENGINEERING MODEL 199
DAY HR/MIN VALUE
1 0021
OMEGA
OM-202 TEMPERATURE LOGGER
LIST
A INTERVAL 0 = NO LOG 1=10 SEC. 3=10 MIN. 2=1 MIN. 4=1 HR.
B HIGH LIMIT (*)
C LOW LIMIT (*)
D MAX. TEMP. (*)
E MIN. TEMP. (*)
F CHANNEL NUMBER (1-10) DWELL IN SEC (2-9)
G DAY (1-7) HOUR (0-23) MINUTE (0-59)
H CHANNELS (1-10) VALUES (*)
* −1999° TO +1999°C or °F
DAY (1-7) 7
CHANNEL (1-10) 8
TIME (0000-2359) 9
HI LIMIT (±1999) 4
DWELL (2-9) SEC 5
INTERVAL (0-4) 6
LOW LIMIT (±1999) 1
LIST 2
± SIGN 3
CHANNEL: HOLD, CYCLE (1-10) (0) 0
PAPER FEED
7 8 9 4 5 6 1 2 3 0
OM-202-M MULTIPLEXER
CHANNEL INDICATOR
ON OFF POWER

The **OM-202 SERIES** is a new family of specialized data recording instruments designed to give you new options in process monitoring and data recording: digital accuracy, with programmable functions at strip chart recorder prices.

DIGITAL VALUE DISPLAY—The analog signal is converted to a digital value and displayed.

DATA RECORDING—Data is recorded by a hard-copy printout on 2¼ inch thermal paper tape; actuated by data logging program or external trigger. Data logging is programmable at 10 sec, 1 min, 10 min, or 1 hr. intervals.

REAL TIME DOCUMENTATION
All recorded data is documented as to day (1-7), hour (0-23), and minute (0-59).

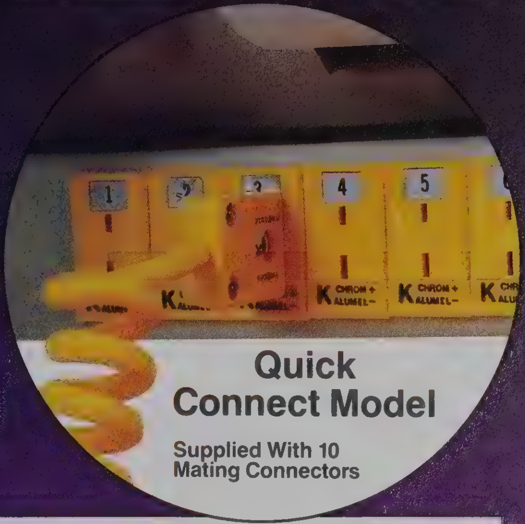
DATA ALARM LIMITS—Out of process parameter conditions can be detected by programmable alarm limits. High and low value limits are set using front panel keyboard. Meeting or exceeding these limits will result in automatic data capture with time documentation, an audible alarm, and an external 5 V dc CMOS output.

MIN, MAX VALUE REGISTERS
Minimum and maximum values are held in internal memory for print by a list function.

75 C
J
OMEGA ENGINEERING MODEL 199
OMEGA
OM-202 TEMPERATURE LOGGER

Temperature Logger
Model OM-202

$795
1 channel unit



Quick Connect Model

Supplied With 10 Mating Connectors

Range Table

Order Code	Sensor Type	Material Type	Range	Overall Error	Resolution
JC JF	J	**Iron/Constantan** (Iron vs. Copper Nickel)	−180° to 760°C −170° to 1400°F	±1.5°C ±1.5°F	1°C 1°F
KC KF	K	**Chromel/Alumel** (Nickel-Chromium vs. Nickel-Aluminum)	−50° to 1250°C −50° to 1999°F	±2.1°C ±2.5°F	1°C 1°F
TC TF	T	**Copper/Constantan** (Copper vs. Copper Nickel)	−150° to 400°C −245° to 750°F	±1.5°C ±2.5°F	1°C 1°F
EC EF	E	**Chromel/Constantan** (Nickel-Chromium vs. Copper-Nickel)	−95° to 840°C −75° to 1440°F	±2.1°C ±2.5°F	1°C 1°F

Order Code	Sensor Type	Material Type	Range	Overall Error	Resolution
RC	R	**Platinum 13% Rhodium vs. Platinum**	300° to 1750°C	±2.5°C	1°C
SC	S	**Platinum 10% Rhodium vs. Platinum**	335° to 1750°C	±2.3°C	1°C
BC	B	**Platinum 30% Rhodium vs. Platinum 6% Rhodium**	745° to 1820°C	±1.9°C	1°C
P1	RTD	**Platinum-100 ohm**	−200° to 800°C −328° to 1492°F	±1.4°C ±1.9°F	1°C 1°F
P2		Alpha=.00385 ohms/°C DIN 43760	−170.0 to 199.9°C −170.0 to 199.9°F	±0.2°C ±0.2°F	0.1°C 0.1°F

RTD Models are Switch Selectable for °C or °F.

How To Order Your OM-202
Most Styles and Ranges In Stock For Immediate Delivery

Description	Input Connections	Catalog No.	Price
Thermocouple Input	**Only One Thermocouple Type per Instrument**		
1 Channel	Screw Terminals	OM-202-⊡-1-SCT	$ 795
10 Channel	Screw Terminals	OM-202-⊡-10-SCT	1294
10 Channel	Quick Disconnect	OM-202-⊡-10-MPJ	1349
RTD Input			
1 Channel	Screw Terminals	OM-202-🅃-1-SCT	889
Options/Accessories			
Replacement Paper	3 Rolls	OM-202-RP	$ 5
Power Option	220 V ac	Specify 1 Channel	40
	220 V ac	Specify 10 Channel	55

⊡ Specify Thermocouple Order Code From Range Table above.
🅃 Specify RTD Order Code P-1 or P-2 From Range Table above.

Specifications

	10 Channel Unit	1 Channel Unit
Thermocouple Inputs	J, K, T, E, R, S, or B	J, K, T, E, R, S, or B
RTD Input Platinum RTD	—	100 ohms α = .00385
Sampling Channel Interval	16 milliseconds Select 2 to 9 seconds per channel	16 milliseconds
Recording Interval	Select 10 sec, 1 min, 10 min or 1 hour	Select 10 sec, 1 min, 10 min or 1 hour
Alarms Set	Select −1999 to +1999 degrees C or F	Select −1999 to +1999 degrees C or F
Input Terminals	Screw jaws for up to 14 gage wire or miniature jacks for SMP connectors, optional	Screw Terminals
Relay Life	3 × 10^8 cycles	—
Size	9.5″ (241 mm) sq by 7.4″ (188 mm) high	9.5″ (241 mm) sq by 5.5″ (140 mm) high
Weight	8.5 lbs (3.9 kg)	5.5 lbs (2.5 kg)

Data Loggers

Model OM-205

Powerful but compact

- Up to 36 Channels
- 9 Programmable Alarms
- Mixed Inputs (3 Groups)
- Programmable Logging Schedule

"Big performance——but small enough to fit under an airplane seat"

H: 5.5″ (139 mm)
W: 10.5″ (266 mm)
D: 16″ (406 mm)

Only 18 to 22 pounds (8.1-9.9 kg)

05 0073 F
PRGM
HI
%
LO
°F
mV
°C
V
POWER
OMEGA
205
7
8
9
4
5
6
1
2
3
0

Remote Computer Interface with Serial I/O Option

Color coded Handle Probes See Section A.

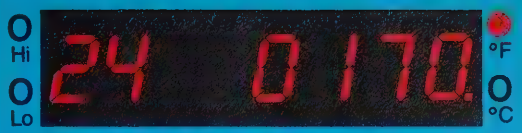
Four types of inputs can be used with one OM-205.

- Thermocouples
  J,K,T,E,R,S,B
- Platinum RTD's
- Current Loops
  4-20 mA
  10-50 mA
- Linear Voltage Transducers
  from –100 mV to 100 V

Quick Disconnect Probes
See Section A.

Protection Head Probes
See Section A.

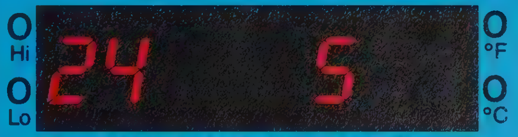
Temp



Hi
Lo
24 0170
°F
°C

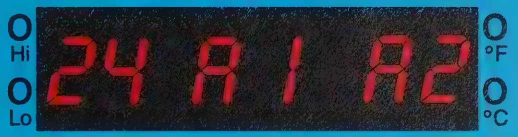
Point #24 is at 170°F (77°C)

Skip



Point #24 is skipped in automatic schedule

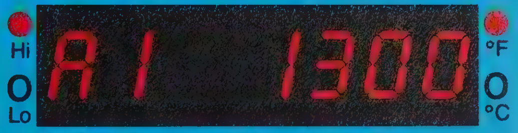
Alarm Assign



Hi
Lo
24 A1 A2
°F
°C

Point #24 is assigned alarm limits #1 and #2

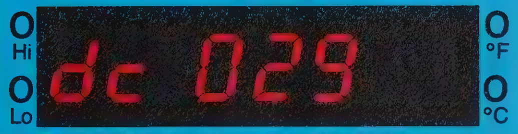
Alarm Limit



Hi
Lo
A1 1300
°F
°C

High limit assigned to alarm #1 at 1300°F (704°C)

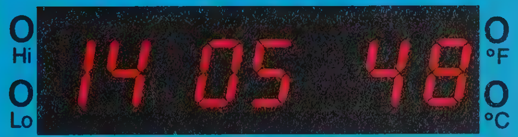
Day/Date



Hi
Lo
dc 029
°F
°C

Day 029 is assigned to "today"

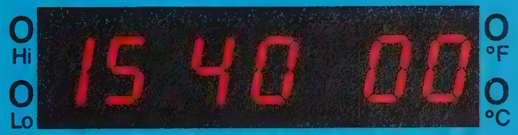
Time



Hi
Lo
14 05 48
°F
°C

Current time is 2:05:48 (p.m.)

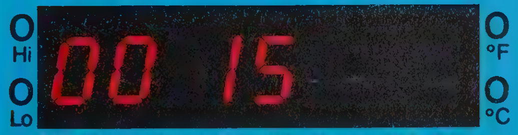
Auto Log



Hi
Lo
15 40 00
°F
°C

Next automatic logging of (unskipped) points is at 3:40 p.m.

Interval



Hi
Lo
00 15
°F
°C

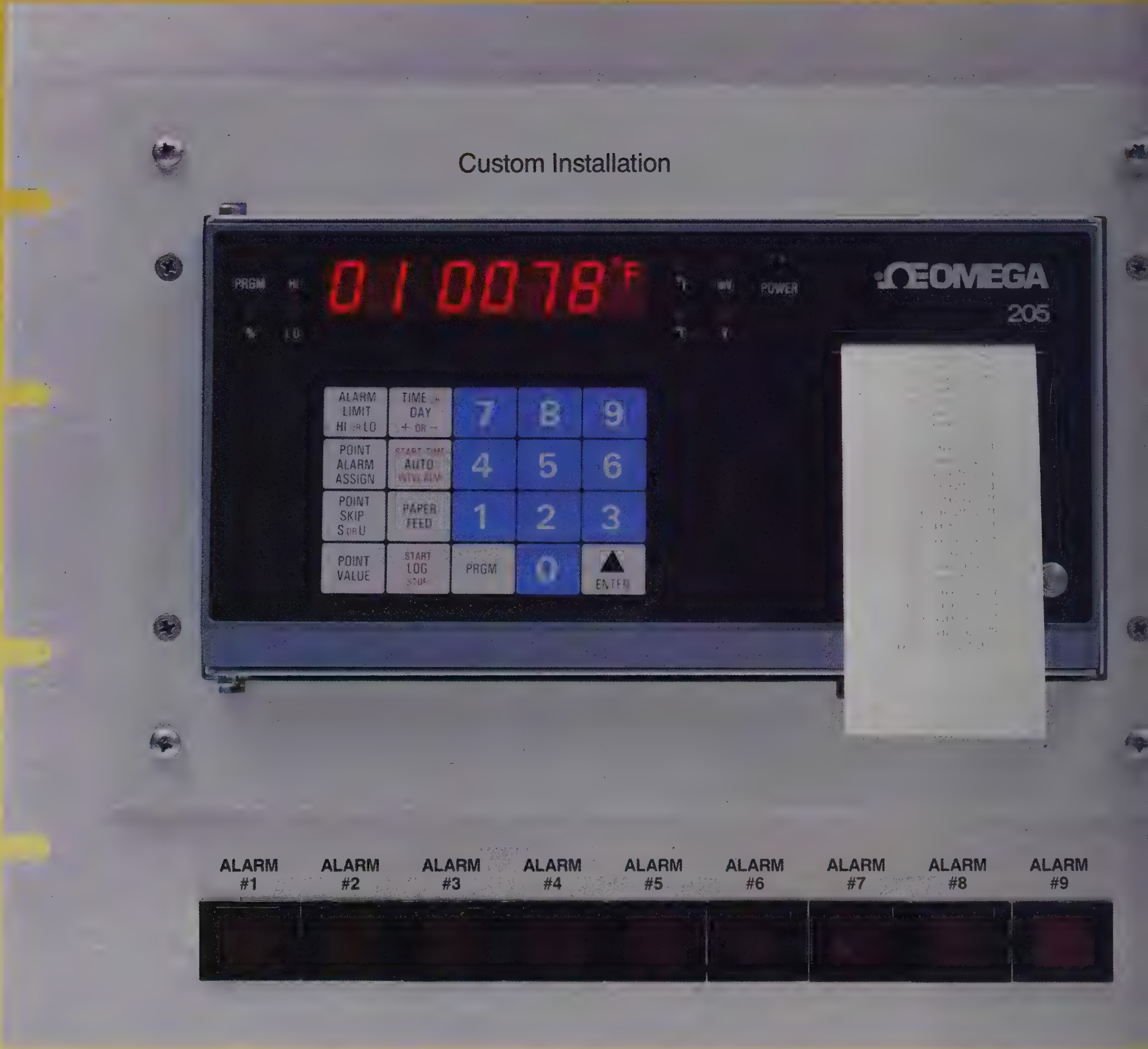
Unskipped points will be logged in 15 minute intervals

12 channel unit

$2,900

Data Logger
Model OM-205

One Multiplexer Board	Two Multiplexer Boards	Three Multiplexer Boards
$2,900	$3,425	$3,950


Custom Installation
PRGM
HI
%
LO
01 0078 °F
POWER
OMEGA
205
ALARM LIMIT HI OR LO
TIME DAY + OR −
POINT ALARM ASSIGN
START TIME AUTO INTVL ALM
POINT SKIP S OR U
PAPER FEED
POINT VALUE
START LOG STOP
PRGM
ENTER
7
8
9
4
5
6
1
2
3
0
ALARM #1
ALARM #2
ALARM #3
ALARM #4
ALARM #5
ALARM #6
ALARM #7
ALARM #8
ALARM #9

Easy Programming

Ten function keys and ten numeric keys do it all. Simple, color-coded touch pad permits operator to set logging schedule, read values on demand, set and assign alarms, and perform all operations. For system security, internal switch can inhibit unauthorized use of touch pad.

Versatile

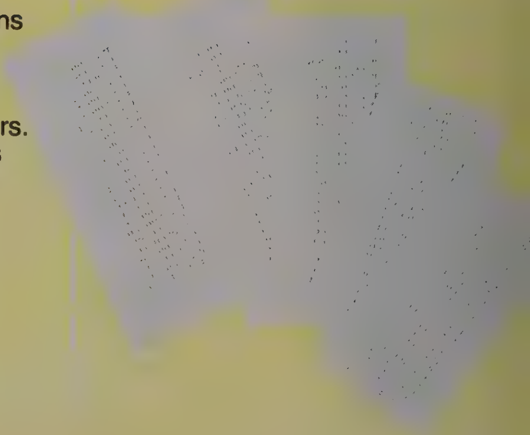
Controls visual and audible alarms when alarm I/O and ARP options are chosen.

Documentation

Programmable. Printing instructions are under operator control. Prints selected channel readings when scheduled, and any alarm status change regardless of when it occurs. Records channel values as well as day, time, and exceeded limit.

Shows:

- **Temperature**
- **Alarm**
- **Time**
- **Date**



MASTER AUDIO ALARM
ON-OFF

Mainframe

- Microprocessor Control
- Battery Backed-Up Program Memory
- Touchpad Program Input
- Digital LED Display
- Thermal Printer
- Nine Programmable Alarm Limits
- Real Time Clock
- Three MUX Slots
- Two Option Slots

Multiplexers

- Reed Switching
- Single Type of Input for Each Board
- Field Switchable
- 8 RTD Inputs per Card
- 12 T/C, V or I Inputs per Card

Serial I/O Option S

- RS-232C or 20 mA Current Loop
- Remote Programming and Logging
- Initiate Logs or Program Separate
- Log Intervals From Front Panel

Alarm Relay Option A

- Common Alarm Master Relay
- Logic Output for ARP Alarm Relay Panel
- Selectable Deadband, Average Deviation or Tracking Functions

Alarm Relay Panel Option ARP

- Master Relay Plus 9 Control Relays
- Form C 2AMP Non-Inductive Contacts

EXPANDED RANGE SELECTION

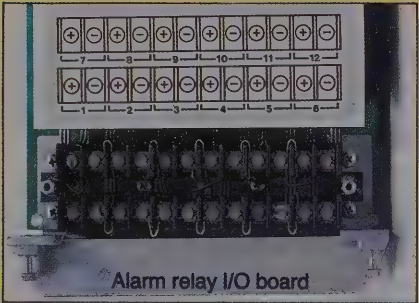
Range Selection Guide

Range Designation	Input Type	Input Range	Resolution	Accuracy	MUX Board
JF JC	**J** Iron vs. Constantan	–328° to 1712°F –200° to 933°C	1°	±1°	M1 or M2
KF KC	**K** Chromel vs. Alumel	–208° to 2551°F –133° to 1399°C	1°	±1° ≥ 0°F ±1½° < 0°F ±1°C	M1 or M2
TF TC	**T** Copper vs. Constantan	–328° to 751°F –200° to 399°C	1°	±1°	M1 or M2
EF EC	**E** Chromel vs. Constantan	–327° to 1951°F –199° to 1066°C	1°	±1°	M2
RF RC	**R** Pt vs. Pt 13% Rh	32° to 3251°F 0° to 1788°C	1°	±2° ≥ 350°F ±3° < 350°F ±2°C	M1
SF SC	**S** Pt vs. Pt 10% Rh	32° to 3251°F 0° to 1788°C	1°	±2° ≥ 600°F ±3° < 600°F ±2°C	M1
BF BC	**B** Pt 6% Rh vs. Pt 30% Rh	912° to 3392°F 489° to 1866°C	1°	±4°F ±3°C	M1
Pt F	100Ω Pt $\alpha = 0.00385$	–387° to 1632°F	1°	±1°	M3
Pt .1 F Pt .1 C	100Ω Pt $\alpha = 0.00385$	–387.9° to 999.9°F –233.3° to 887.8°C	0.1°	±.4°F ±.2°C	M3
I1	Current Loop	4 to 20 mA	0 to 100.0% From Factory—User Variable Offset & Span	±1 Count	M4
I2	Current Loop	10 to 50 mA		±1 Count	M4
V1	25 mV	–10 to 25 mV dc	10μV	±2 Counts	M2
V2	250 mV	–100 to 250 mV dc	100μV	±1 Count	M2
V3	2.5 V	–1 to 2.5 V dc	1 mV	±1 Count	M2
V4	25 V	–10 to 25 V dc	10 mV	±1 Count	M2
V5	Process Voltage	0 to 5 V dc	0 to 100.0% or User Variable	±2 Counts	M5
V6	100 V	–50 to 100 V dc	100 mV	±2 Counts	M2

NOTE: The multiplexer (MUX) card range programming works with a custom LSI circuit in the mainframe to provide the required signal conditioning and scaling. As the LSI chip for the M1 board is unique to it, M1 MUX boards cannot be mixed with any other type MUX board. If an M1 system is specified, only thermocouples can be programmed as inputs.

Data Logger
Model OM-205 Accessories

Alarm relay panel
MUX boards
Vinyl carrying case
Paper holder



Alarm relay I/O board

Tilt stand

PRICE INFORMATION— OM-205 Options and Accessories

Catalog Number	Description	Price
OM-205	Basic system including program entry touch pad, touch pad lock, .5″ digital display, thermal printer, digital clock and calendar, 9 programmable alarm controls, LSI function chip, ac power supply, power cord, backup battery for up to 30 days of power failure, operator's manual, one pack of paper. For 12 input channels (includes 1 MUX board)	**$2,900**
	For 24 input channels (includes 2 MUX boards)	**3,425**
	For 36 input channels (includes 3 MUX boards)	**3,950**
OM-205-M1*	Extra 12 channel multiplexer (MUX) card for thermocouple types J, K, T, R, S, and B. Calibration field selectable.	**580**
OM-205-M2	Extra 12 channel multiplexer (MUX) card for thermocouple types J, K, T, E, variable voltages. Calibrations are field selectable.	**580**
OM-205-M3	Extra 8 channel multiplexer (MUX) card for platinum RTD's. Calibrated for $\alpha = 0.00385$.	**580**
OM-205-M4	Extra 12 channel multiplexer (MUX) card for variable currents 4-20 mA or 10-50 mA. Factory set 0-100%.	**580**
OM-205-M5	Extra 12 channel multiplexer (MUX) card for variable voltage input 0-5 V. Factory set 0-100%.	**580**
OM-205-SC-02	MUX extender card.	**75**
OM-205-S	Optional serial I/O board.	**580**
OM-205-A	Optional alarm relay I/O board.	**475**
OM-205-LSI-M1	Extra LSI chip for MUX board M1. Enables OM-205 for M1 MUX boards.	**100**
OM-205-LSI-M2	Extra LSI chip for MUX board M2, M3, M4, and M5. Enables OM-205 for M2, M3, M4, and M5 MUX boards.	**100**
OM-205-ARP	Alarm relay panel with 9 control relays plus one master relay.	**580**
OM-205-W6	Rack mount adaptor for EIA 19″ (482 mm) rack, 8 ½″ (216 mm) high.	**125**
OM-205-P	19″ Rack panels (special order)	*By Quotation*
OM-205-W1	Panel mount kit, cutout 7.35″ (186 mm) high, 12.3″ (312 mm) wide.	**60**
OM-205-KS	Bench tilt stand and carrying handle.	**30**
RCC-205	Vinyl carrying case.	**75**
OM-205-ZFP	Z-fold paper, 25 pkgs., thermal type	**110**
OM-205-ZFH	Z-fold paper holder.	**35**
OM-205-C1	RS 232C cable to terminal (male).	**65**
OM-205-C2	RS 232C cable to modem (male).	**65**
OM-205-C3	RS 232C cable to terminal (female).	**65**
OM-205-C42	RS 232C cable to TTY (spade lugs).	**65**
OM-205-C44	RS 232C cable to ADM-3A (male).	**65**
M-127	Operator's manual.	**25**

DIN thermocouple MUX board and LSI chip available. Audio/visual alarm panel also available. Consult Sales Department.

How to Order

Up to 3 MUX boards may be ordered per table on page R-50. Each MUX board can handle up to 12 channels of the same type. For each MUX board include an entry for [1] and [2] below. Use model number as shown.

Model No. OM-205—[1][2]—[1][2]—[1][2]—options
(Channels 1-12 13-24 25-36)
[1] = range designation: see chart on preceding page.
[2] = MUX board: M1*, M2, M3, M4 or M5

Options

Serial I/O board, enter: S
Alarm relay I/O board, enter: A
Input power, 115 V ac is standard. If required, enter option: 220 V ac, 240 V ac, or 100 V ac.

Example:
OM-205—JCM1—KCM1—RCM1—A Will handle 12 type J, 12 type K, and 12 type R thermocouples. The OM-205 will read in °C for all three input types, will operate on standard 115 V ac power and contain the optional alarm relay I/O board.

**MUX board M1 cannot be used in the same OM-205 as M2, M3, M4 or M5.*

Digital Meter Interfaces

Analog Output, What it is:

Analog output is a signal, usually millivolts or milliamps which is a function of the input signal. For example, if the analog output is specified as one millivolt per degree Celsius and the temperature display on the meter is 234 degrees Celsius, the analog output will register 234 millivolts.

How to interface it:

Many millivolt strip chart recorders will directly accept the analog output from a digital panel meter. If the analog output is specified as one millivolt per degree Fahrenheit, and the maximum temperature is 657 degrees Fahrenheit, then the one volt range on the strip chart recorder should be selected, giving a range of 0 to 1000°F on the chart.

Beware of ground loops:

Some electronic instruments do not have isolation between inputs and outputs. If this is the case, only one reference ground can be connected in the system. For example, if the analog output of a Model 199 meter is connected to a ground referenced recorder, and a grounded probe is used, there need be only a small voltage difference between the two ground points for a large current to flow through the lead wires and meter. At best, this will cause errors and at worst could cause damage.

Serial Output, What it is:

Serial output is a form of digital output. A serial format implies that information is output one character at a time. For example, if the information to be transmitted is "234.5 PSI" a serial format might send the information as 2, 3, 4, 5, one character at a time.

How to interface it:

In order to interface serial output, it is necessary to know what code is used to represent characters and what signal levels and connections are used by the devices to be interfaced.

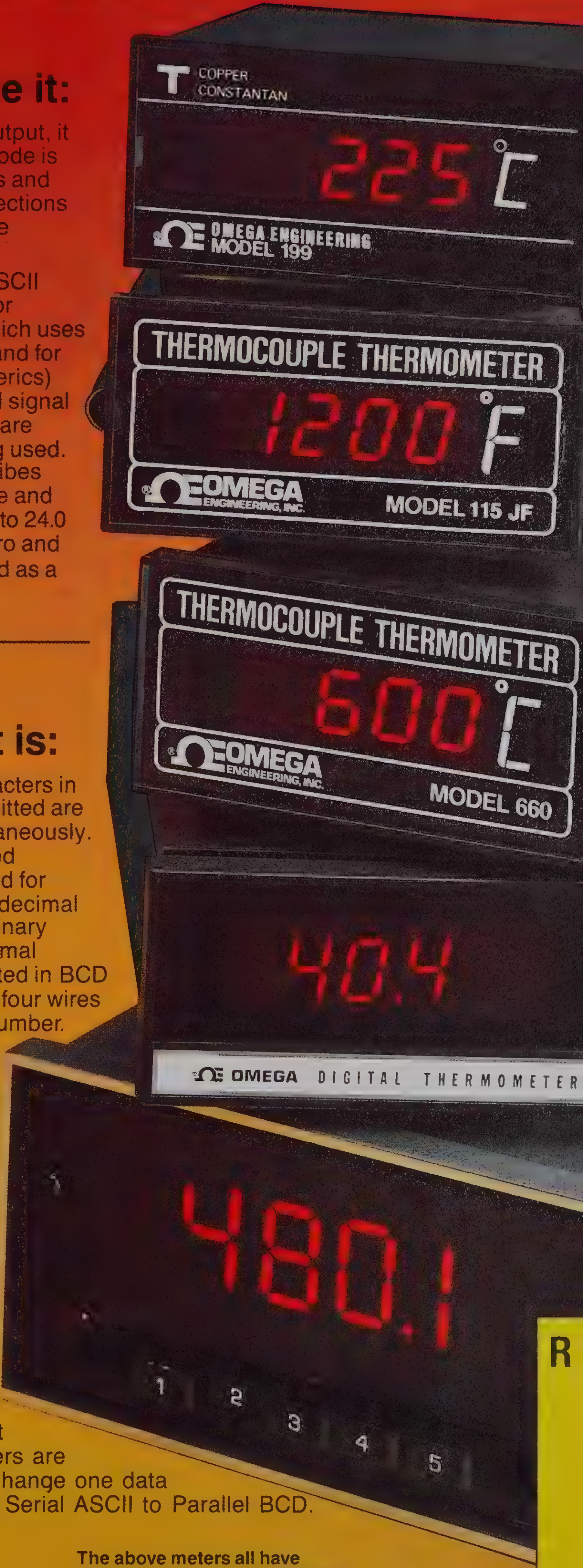
A commonly used code is ASCII (American Standard Code for Information Interchange) which uses numbers from 0 to 255 to stand for letters, numbers (alphanumerics) and control functions. Actual signal levels and wire connections are defined by the devices being used. RS232C, for example, describes which wires transmit, receive and coordinate data transfer. 3.0 to 24.0 V dc is defined as a logic zero and −3.0 to −12.0 V dc is defined as a logic one.

Parallel BCD Output, What it is:

Parallel means that all characters in the information to be transmitted are present at the output simultaneously. BCD stands for Binary Coded Decimal. It refers to a method for representing each digit of a decimal number as a group of four binary digits. For example, the decimal number 23 can be represented in BCD as 0010 0011. BCD requires four wires for each digit of a decimal number.

How to interface it:

Parallel BCD is used to drive some computer data acquisition systems and programmable controllers. Depending on the particular system setup, it might be necessary to run four wires per digit of information required. If the system uses a different system than BCD, converters are commercially available to change one data format to another, such as Serial ASCII to Parallel BCD.



The above meters all have computer interface capabilities. See section M for specifications.

Data Cables
EIA/RS-232C Compatible

- Low Profile (Only .620″ High)
- Total Stress-Relief
- Permanent Contact Seating
- Total Connector Shielding
- Conductive Tinned Connectors For Positive Grounding
- Low Cost, High Performance

OMEGA ENGINEERING, INC.

Shielded Cable

Solder Flow For Positive Contact Between Shield And Connector Shell

Finger Grip

Conductive Mounting Hardware

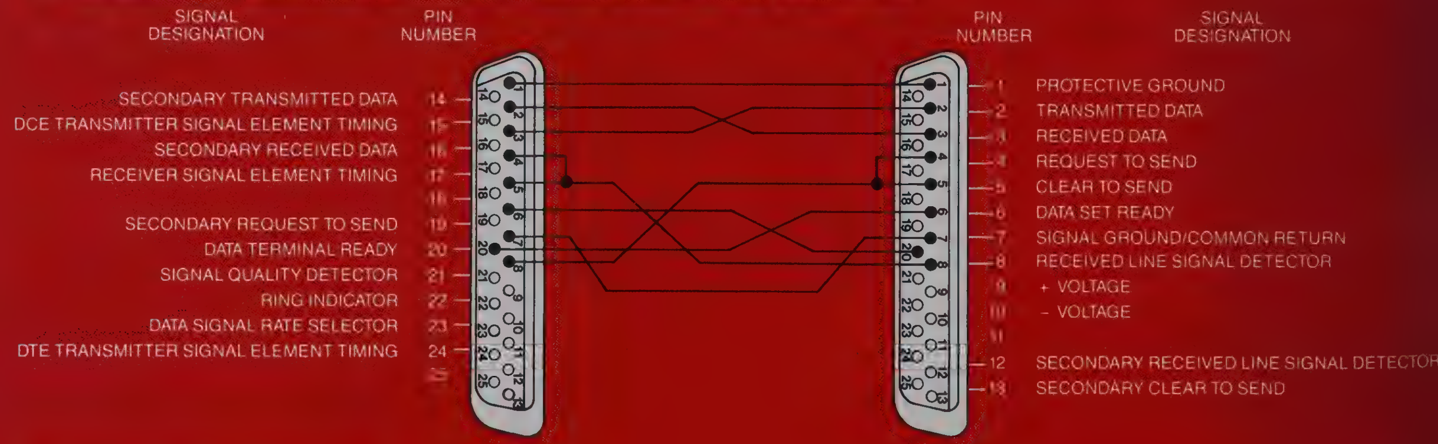
Copper foil shield over plastic primary mold for total stress-relief

Tin Plated "D" Subminiature Connector

Off-The-Shelf Delivery

Description	Part Number	5′	10′	25′	To Complete Part Number, Enter:
Four Line With Handshake Jumpers	OC4-[1]-[2]-[3]	$20	$25	$35	1. TYPE: M = Modem Type Cable N = Null Modem Type Cable
9 Line Cable Wired 1-8 and 20	OC9-[1]-[2]-[3]	$25	$30	$40	2. TERMINATION: MM = Male To Male MF = Male To Female FF = Female To Female
Full 25 Line Extension Wired Pin to Pin Only	OC25-[M]-[2]-[3]	$35	$40	$55	3. LENGTH: 5 Feet 10 Feet 25 Feet

TYPICAL NULL-MODEM CONNECTIONS


SIGNAL DESIGNATION
PIN NUMBER
SECONDARY TRANSMITTED DATA 14
DCE TRANSMITTER SIGNAL ELEMENT TIMING 15
SECONDARY RECEIVED DATA 16
RECEIVER SIGNAL ELEMENT TIMING 17
18
SECONDARY REQUEST TO SEND 19
DATA TERMINAL READY 20
SIGNAL QUALITY DETECTOR 21
RING INDICATOR 22
DATA SIGNAL RATE SELECTOR 23
DTE TRANSMITTER SIGNAL ELEMENT TIMING 24
25
PIN NUMBER
SIGNAL DESIGNATION
1 PROTECTIVE GROUND
2 TRANSMITTED DATA
3 RECEIVED DATA
4 REQUEST TO SEND
5 CLEAR TO SEND
6 DATA SET READY
7 SIGNAL GROUND/COMMON RETURN
8 RECEIVED LINE SIGNAL DETECTOR
9 + VOLTAGE
10 − VOLTAGE
11
12 SECONDARY RECEIVED LINE SIGNAL DETECTOR
13 SECONDARY CLEAR TO SEND

Modem Cables Have Pin-to-Pin Connections

Floppy Disks:

5¼"

NEW!

OMEGA ENGINEERING, INC
OMEGASOFT™
TO ORDER:
DISK 5S
$45 PACKAGE OF 10

- Double Density
- Soft Sectored
- Dual Sided
- Reinforced Center
- Unformatted

$45
Package of 10

ORDER:
Disk 5 S

Solid State Switches
Interchangeable Modules
• AC • DC

OMEGA
ENGINEERING, INC.
STAMFORD, CONN.

Shown larger than actual size to show detail.

- **4000 Volt Isolation**
- **Logic Levels Switch High Level AC And DC Circuits**
- **High Level AC And DC Signals Switch Logic Circuits**

Design Your System:

Switching modules and mounting racks are ordered separately. Simply select the modules required for your application and choose a backplane with enough positions to accommodate them. Empty positions can be left for future expansion.

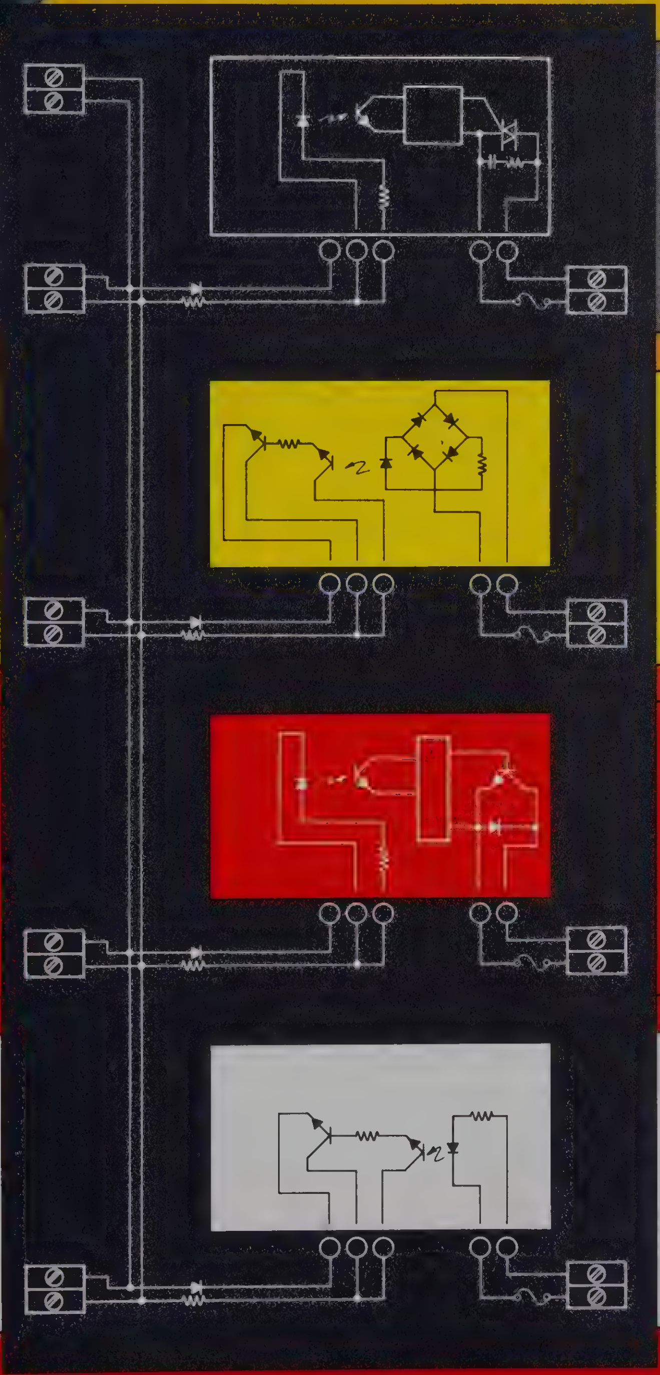
General Specifications

Input Modules

Isolation Input to Output	4000 V
Output Transistor Breakdown	30 V
Output Current	50 mA
Output Leakage— No Input	100 μA max
Output Voltage Drop @ 50 mA	0.4 V
Logic Supply Voltage	4.5 to 6 V
Logic Supply Current	12 mA
Operating Ambient	−30°C to +70

Output Modules

Isolation Output to Input	4000 V
Output Current	3 A
Maximum Contact Drop	1.6 V
Signal Pickup	2.5 V
Signal Dropout	1 V
Maximum Signal	8 V
Signal Input Resistance	220 Ω



AC Output Model AC05

$15

Specifications

- 24 to 280 V ac
- 20 mA Minimum Load
- 5 mA Off State Leakage
- 80 A One Cycle Surge

AC Input Model ACI5

$15

Specifications

- 90 to 140 V ac
- 10 mA Input Maximum
- 20 mS Switching Maximum
- 16 V Allowed For No Output

DC Output Model DC05

$15

Specifications

- 60 V dc Maximum
- 1 mA Maximum Leakage
- 5 A One Second Surge
- Less Than .75 mS Switching

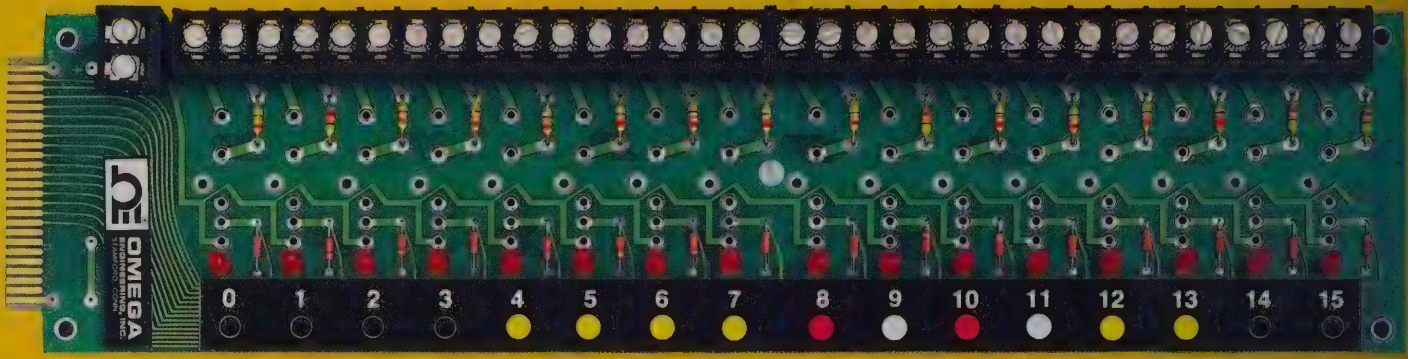
DC Input Model DCI5

$15

Specifications

- 10-32 V dc
- 32 mA Maximum
- 5 mS Switching
- 3 V (or 2 mA) Allowed
- Input For No Output

Solid State Switches
Backplanes and Accessories


OMEGA ENGINEERING, INC. STAMFORD, CONN.
0
1
2
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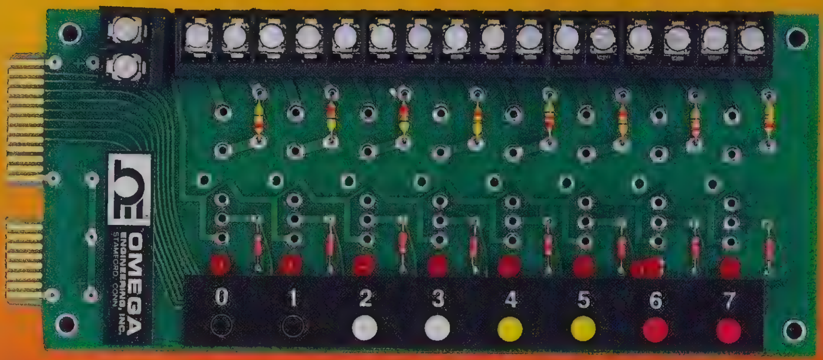
15

SSS-PC16 $100


OMEGA ENGINEERING, INC. STAMFORD, CONN.
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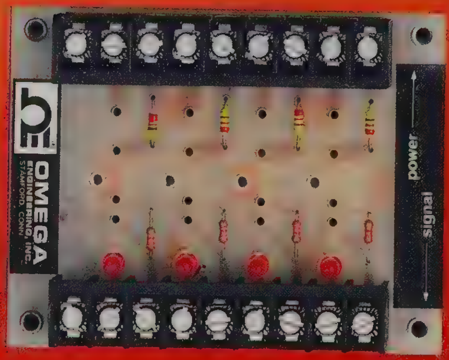
SSS-PC8 $ 60


OMEGA ENGINEERING, INC. STAMFORD, CONN.
power
signal

SSS-PC4 $ 35

Also Available
(not pictured)

SSS-PC4I $ 40

SSS-PC24 $150

OMEGA can supply a complete series of versatile backplanes to mount 4, 8, 16 or 24 modules. The backplanes include LED indicators to indicate signal status, pull-up resistors to avoid undefined states, and power fuses for overload protection on each channel.

SSS-PC4 $ 35

A 4 channel backplane with screw terminal connections. Logic power and ground are common on the signal side.

SSS-PC4I $ 40

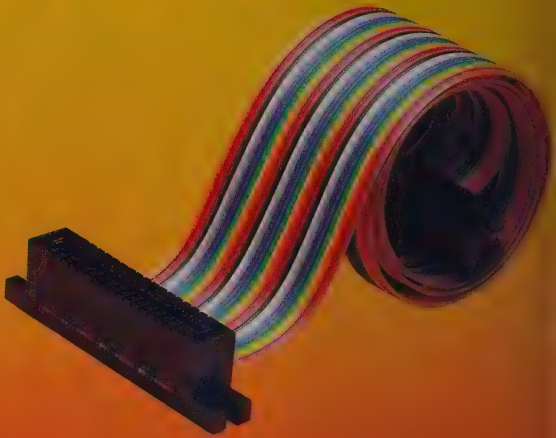
Same as the above except that all channels are isolated from each other. Without the common signal ground, only output modules may be used.

SSS-PC8 $ 60

An 8 channel backplane with channel signals, power and ground busses terminating in card edge fingers. Connection is made with either 26 or 50 pin connectors (0.10″ centers).

SSS-PC16 $100

16 and 24 channel backplanes similar to the SSP-PC8. Only 50 pin card edge connectors.



Connectors and Cables

OMX-1804	**$15**
Solder Eye Type 50 Pin Connector	
SSS-CA2	**$20**
2′ Ribbon Cable With 50 Pin Connecto	
SSS-CA6	**$25**
6′ Ribbon Cable Assembly	
SSS-CA10	**$30**
10′ Ribbon Cable Assembly	

Fuses

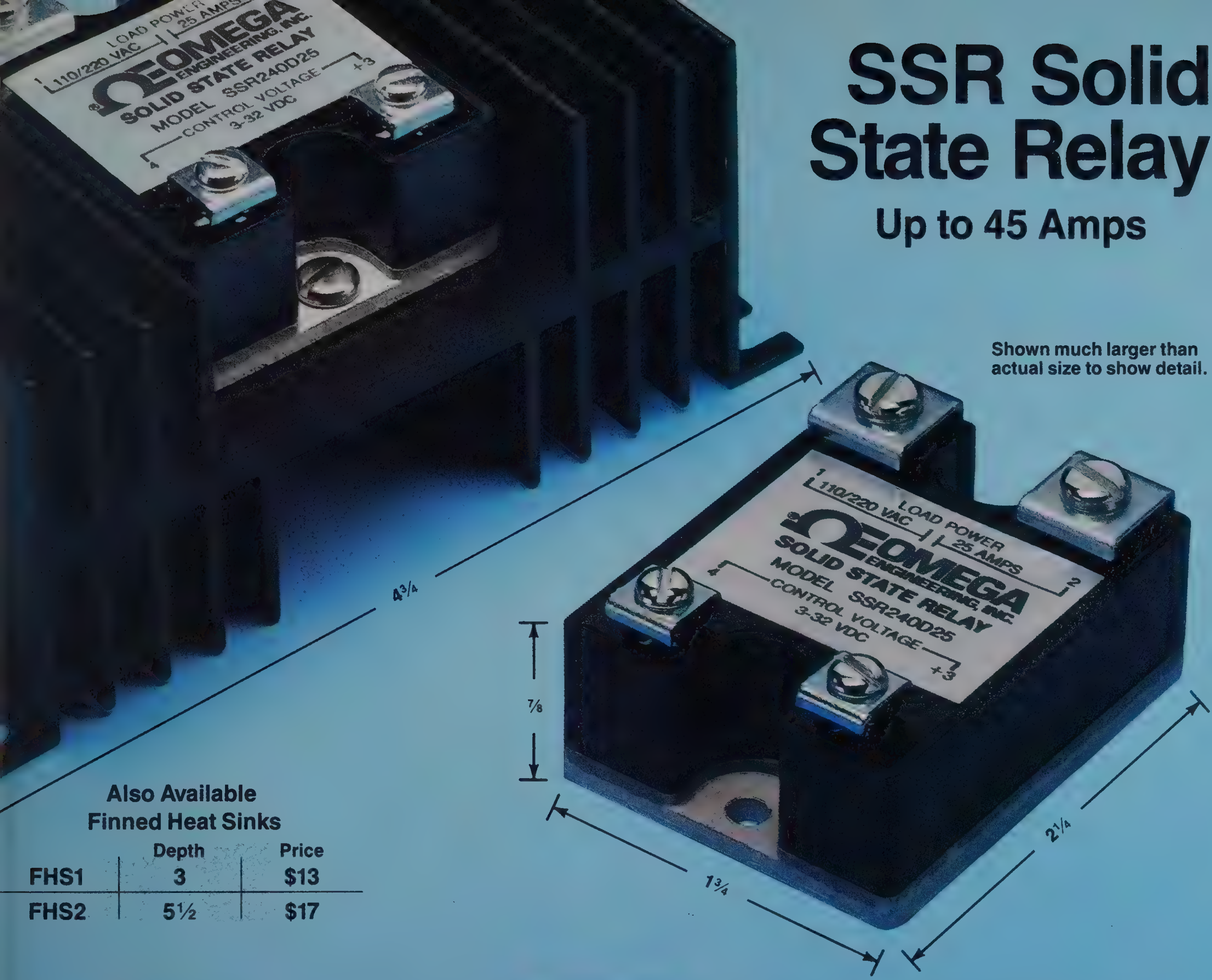
SSS-F1	1 Amp Optional Logic Power Fuse	$2
SSS-F5	5 Amp Spare Channel Power	$2

SSS-PC24 $150

Can be used for signal connections. All edge connections are gold plated over nickel plating for maximum corrosion resistance.

SSR Solid State Relay

Up to 45 Amps



1
110/220 VAC
LOAD POWER
25 AMPS
OMEGA ENGINEERING, INC.
SOLID STATE RELAY
MODEL SSR240D25
CONTROL VOLTAGE
3-32 VDC
2
4
+3
4¾
⅞
1¾
2¼

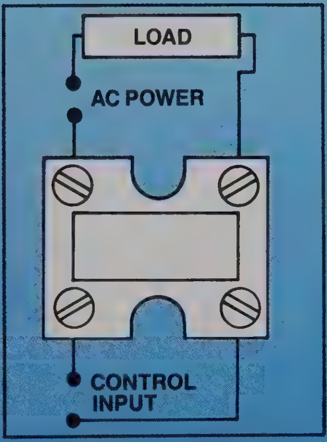
Shown much larger than actual size to show detail.

Also Available Finned Heat Sinks

	Depth	Price
FHS1	3	$13
FHS2	5½	$17

- **2500 Vrms Isolation**
- **AC input**
- **DC input**
- **Switch up to 45A**

An OMEGA Solid State Relay (SSR) is a single-pole, normally open, switching device with no moving parts, capable of millions of cycles of operation. By applying a control signal, the SSR switches "ON" the AC load current, just as moving contacts do on a mechanical contactor.

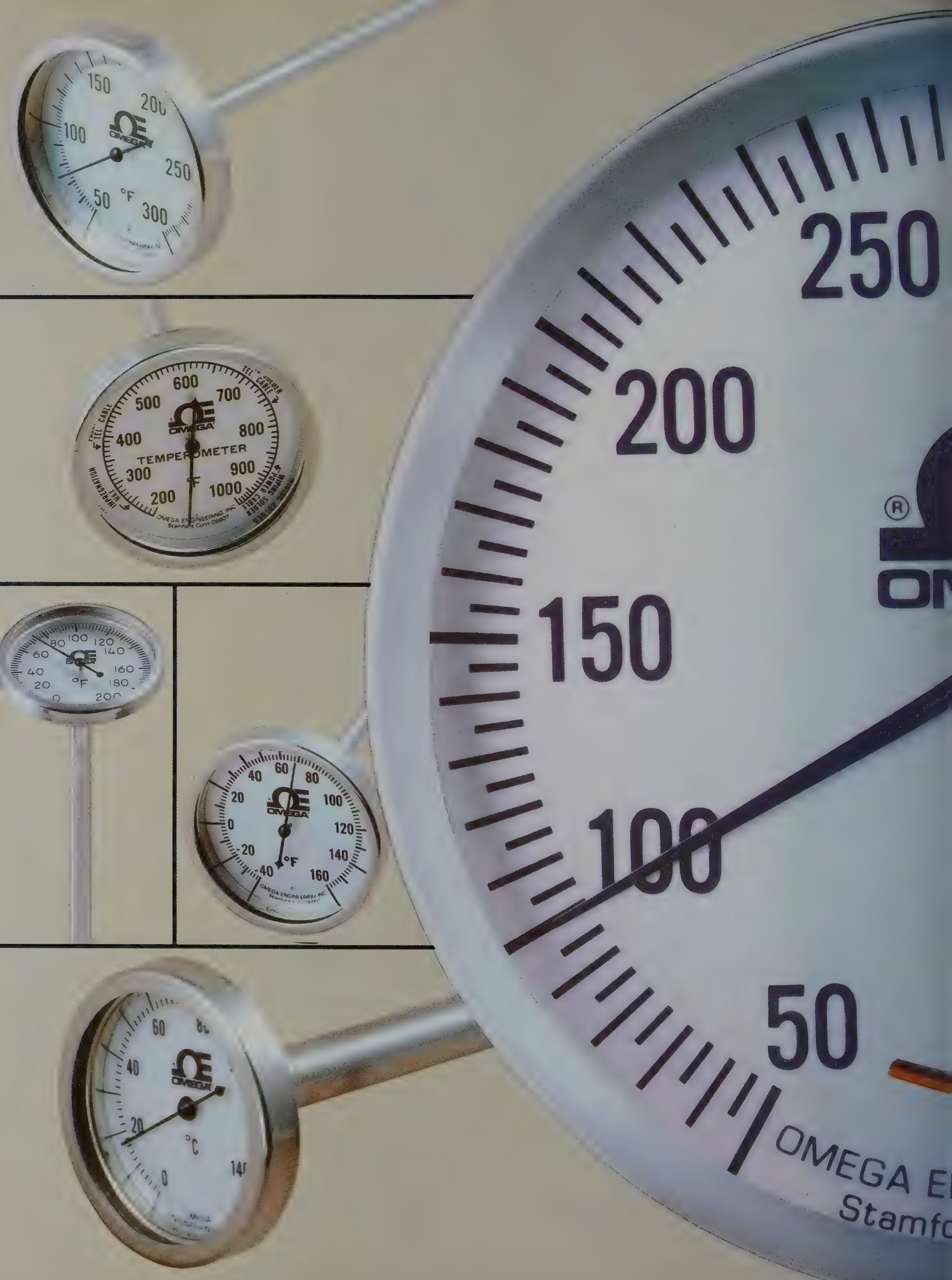


LOAD
AC POWER
CONTROL INPUT

"Switching" takes place at the zero voltage crossover point of the alternating current cycle. Because of this, no appreciable electrical noise is generated, making OMEGA's SSR ideal for environments where there are computers and other apparatus which can be influenced by RF noise.

Complete specifications on page P-58

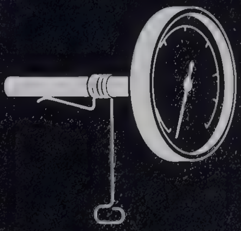
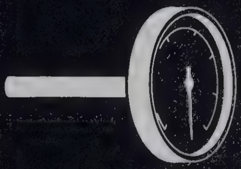
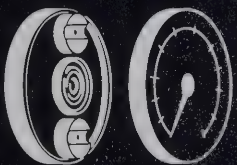
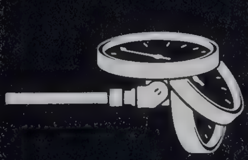
		INPUT-CONTROL SIGNAL		OUTPUT-AC LOAD SIDE		
	Catalog No.	Control Signal Voltage Range	Control Signal Turn-On Voltage	Nominal AC Line Voltage Range	Nominal Load Current	Price
AC Control Signal	SSR 240 A10 SSR 240 A25 SSR 240 A45	85 to 280 V ac	85 V ac	12 to 280 V ac	10 A 25 A 45 A	$27 37 50
DC Control Signal	SSR 240 D10 SSR 240 D25 SSR 240 D45	3 to 32 V dc	3 V dc	12 to 280 V ac	10 A 25 A 45 A	21 26 47


OMEGA
TEMPEROMETER
°F
°C
OMEGA ENGINEERING INC.
Stamford Conn 06907
250
200
150
100
50

300
350
400
45
500
OMEGA

S

Dial Thermometers

Thin Stem Pocket Thermometers		S-3
Dial Thermometers		S-5
Thermowells for Dial Thermometers		S-6
Magnetic Surface Thermometers		S-7
Flexible Head Model J Thermometer		S-8
Prices and Technical Information		S-9

DialTemp™

Thin Stem Pocket Thermometer

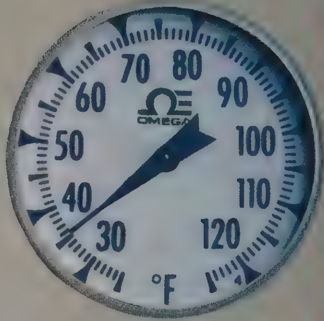
with attractive Stainless Steel pocket case **$20**

OMEG
NGINEER
.C.
60
70
80
90
50
100

Features

- Accurate
- Quick response
- Rugged
- Shock resistant
- Lightweight
- Convenient to use
- Stainless steel construction
- Sensitive bi-metal element
- Clear easy to read pointer to dial
- Unbreakable plastic crystal
- External reset adjustment
- Waterproof and dustproof
- Stainless steel pocket case

Four temperature ranges in Fahrenheit and two in Celsius
(See Model Numbers Below)



Model K

Specifications

Accuracy — 1% of Scale
Head — 1″ Diameter (25mm)
Dial — White background with crisp letters, marks and numbers
Stem — .142 O.D., 5″ Long, Pointed (3.6mm x 127mm)
Reset Nut — 7/16″ Hex (11mm)
Pocket Case — Stainless Steel with Clip & Holder Loop
Weight — .65 ounces (18.5G)
Packed — Individually packaged
Choice of temperature ranges—

K-79-2	−40 to 160°F	K-79-5	50 to 550°F
K-79-3	0 to 220°F	K-79-7	−10 to 110°C
K-79-4	25 to 125°F	K-79-8	0 to 150°C

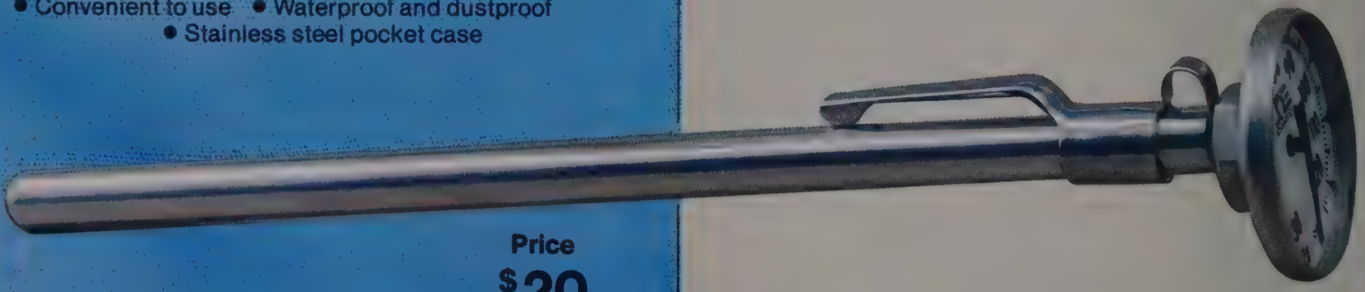
This handy little Pocket Thermometer is great for spot checking temperatures accurately and quickly. The clear easy to read dial with pointer directly driven by the precision sensitive bi-metal helix coil gives an accurate reading every time. The head and stem of stainless steel, the plastic crystal with no mercury or glass makes this thermometer virtually unbreakable. The pocket case is constructed of Stainless Steel and has a safety clip which allows it to be securely fastened to the pocket, preventing the chance of loss, yet easily accessible. Should the need ever arise for resetting the pointer, an external adjustment feature permits simple zero reset in seconds.

This precision built thermometer makes checking fluids, gases or semi-solids quick, easy, and exact. It can be used for testing a multitude of materials in hundreds of fields, such as Air Conditioning, Food Processing, Refrigeration, Cookers, Frozen Foods, Chemicals, Radiators, Meats, Fish, Fruit, Incubators, Milk and Dairy Products, Dishwashers, Soil, Compost, Water, and many other applications,

Operating Instructions

Normal Usage:
Insert stem at least 2 inches in fluids and 4 inches in gases to secure an accurate reading. Can be hand held in most applications, however, to avoid excessive heat exposure to hand, a "holder-loop" is provided on the clip at the top of the Pocket Case. Insert the stem through the loop and the case becomes a holder for the thermometer.

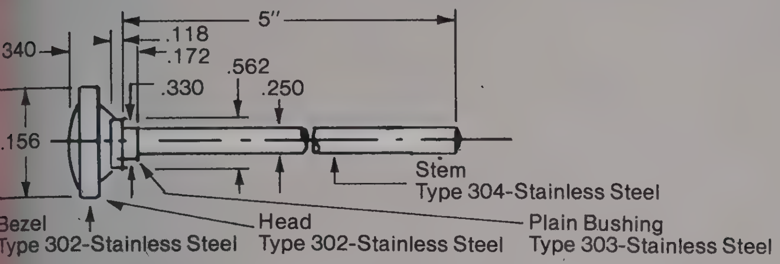
Semi-solid materials:
When inserting into semi-solid materials, such as frozen foods, soils, meat, fish, fruit, etc., hold stem firmly and insert slowly and carefully to avoid bending. Do not hold head when inserting, always hold stem.



Price
$20

Order by specifying Model No.
Temperature Range

Pocket Thermometer with Case
Model QP **Head 1⁵⁄₃₂″ O.D. 5″ Stem**


5″
.340
.118
.172
.562
.330
.250
.156
Stem
Type 304-Stainless Steel
Bezel
Type 302-Stainless Steel
Head
Type 302-Stainless Steel
Plain Bushing
Type 303-Stainless Steel

Used by Inspectors, Technicians, Maintenance and Service men for general testing and checking *refrigeration, hot asphalt, dairy and food products, air conditioning systems, stack temperatures* and hundreds of other uses where a quick temperature indication is needed.

Made entirely of corrosion resistant **Stainless Steel** except optically clear crystal and aluminum dial. Brightly polished head, bezel and stem for sanitation and easy cleaning.

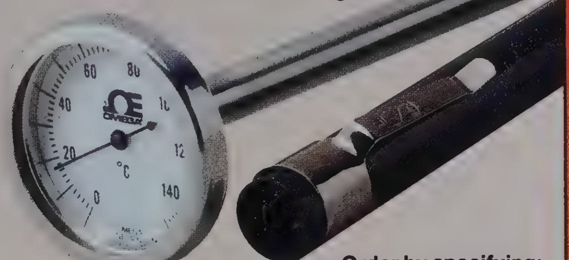
The handy, strong pocket case with pen type clip for safe pocket carrying to prevent accidental loss, is supplied when ordering the Model "QP".

A pointed or "spiked" stem is optionally available for an additional $3.

$24
Any range
Add **$3**
for Pointed Stem

Ranges	°Divisions		
Fahrenheit			
*25-125°F	1°	50- 300°F	2°
*-40-160°F	2°	*50- 500°F	5°
0-200°F	2°	150- 750°F	10°
*0-250°F	2°	200-1000°F	10°
Centigrade			
-40- 70°C	1°	0-150°C	2°
0- 100°C	2°	0-300°C	5°
-10- 110°C	2°		

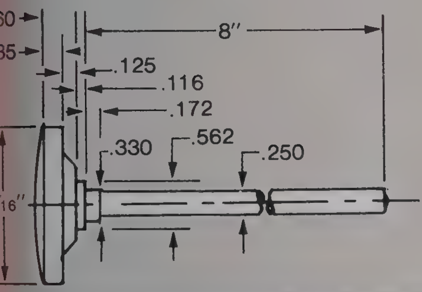
***Off the Shelf Ranges**

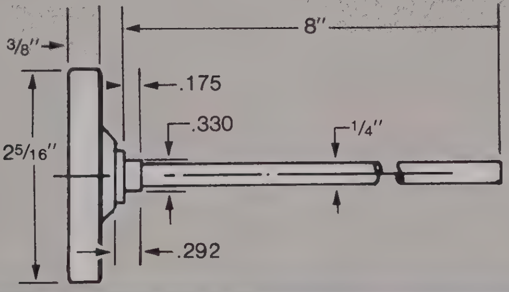

60
80
40
1(
20
12
°C
0
140
OMEGA

Order by specifying:
Model QP and Range.

Lab and Test Thermometers
Models GL and HL **Heads: GL-1¹¹⁄₁₆″ O.D., HL-2⁵⁄₁₆″ O.D.**

Made entirely of Stainless Steel except dial


60
35
8″
.125
.116
.172
.562
.330
.250
16″


3/8″
8″
.175
.330
1/4″
2⁵⁄₁₆″
.292

Model GL
$29
Add **$3**
for Pointed Stem

Model HL
$30
Add **$3**
for Pointed Stem

Ideal for the Lab or Testing: Air, Asphalt, Babbit, Cement, Chemicals, Food, Grain, Water, Waste, Etc.

Clear Easy to Read
8″ Stem
Standard

"GL" Ranges and °Divisions

Fahrenheit					
*25-125°F	1°	*0-250°F	2°	50- 500°F	5°
-40-160°F	2°	-50-300°F	10°	*150- 750°F	10°
0-200°F	2°	50-300°F	2°	200-1000°F	10°
Centigrade					
*0-100°C	1°	*0-150°C	1°	0-300°C	5°
DUAL 50-300°F 2° / 10-150°C 1°					

"HL" Ranges and °Divisions

Fahrenheit					
25-125°F	1°	0-250°F	2°	*50- 500°F	5°
-40-160°F	2°	*50-300°F	2°	150- 750°F	10°
*0-200°F	2°			200-1000°F	10°
Centigrade					
-40- 70°C	1°	-10-110°C	1°	*0-300°C	5°
*0-100°C	1°	0-150°C	1°		

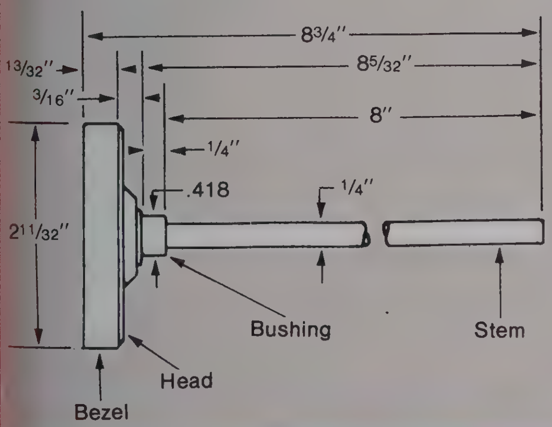
80
100
120
60
140
40
160
20
°F
180
0
200
OMEGA

Order by Specifying:
Model and Range

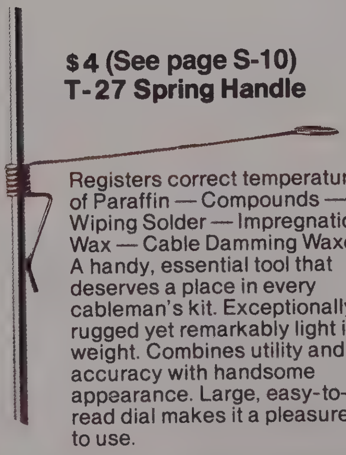
***Off the Shelf Ranges**

The "Temperometer" with T-27 Spring Handle
Model T **Head: 2¹¹⁄₃₂″ diameter**

All Stainless Steel Construction


8³⁄₄″
13/32″
8⁵⁄₃₂″
3/16″
8″
1/4″
.418
1/4″
2¹¹⁄₃₂″
Bushing
Stem
Head
Bezel

$4 (See page S-10)
T-27 Spring Handle

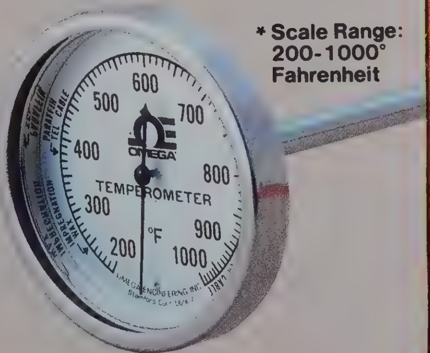


Registers correct temperatures of Paraffin — Compounds — Wiping Solder — Impregnation Wax — Cable Damming Waxes. A handy, essential tool that deserves a place in every cableman's kit. Exceptionally rugged yet remarkably light in weight. Combines utility and accuracy with handsome appearance. Large, easy-to-read dial makes it a pleasure to use.

***Off the Shelf Ranges**

$33

*** Scale Range:**
200-1000°
Fahrenheit


600
500
700
400
OMEGA
800
TEMPEROMETER
300
900
200
°F
1000

Order by Specifying: Model T

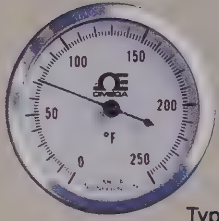
Model Q

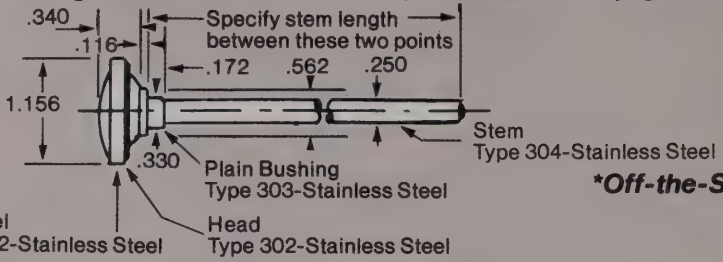
Normally supplied with plain bushing — Optional Threads 1/4″ NPT, 1/2″ NPT, 3/8-24 NF

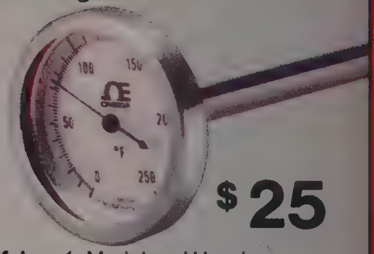
Head 1⁵⁄₃₂″ O.D. 9″ Stem Length Standard—other stem lengths available. See page S-9.

Ranges	°Divisions		
Fahrenheit			
25-125°F	1°	*50- 300°F	2°
−40-160°F	2°	*50- 500°F	5°
*0-200°F	2°	150- 750°F	10°
*0-250°F	2°	200-1000°F	10°
Celsius			
−40- 70°C	1°	0-150°C	2°
*0-100°C	2°	0-300°C	5°
−10-110°C	2°		

**Off-the-Shelf Ranges*




.340
.116
Specify stem length between these two points
.172
.562
.250
1.156
.330
Stem Type 304-Stainless Steel
Plain Bushing Type 303-Stainless Steel
Bezel Type 302-Stainless Steel
Head Type 302-Stainless Steel



For installations on any type of equipment or in any location where mounting space must be carefully considered, the Model Q usually provides the perfect answer! External diameter of head is only 1⁵⁄₃₂″. Despite this compact size, the dial is extremely legible. Model Q Thermometers receive the same meticulous care in assembly and calibration as do all larger instruments. They are in every sense a fine laboratory device yet are so ruggedly made that they will stand up under all usual service conditions. All metal parts of the Model Q, (except aluminum dial), are made from highest quality stainless steel. No problems with rust or corrosion. Crystal is optically clear. It is pressure fitted between the head and bezel. Stem diameter is 1/4″. All parts are brightly polished after assembly so that final units present a handsome, sparkling appearance.

$ 25

Order by Specifying: 1. Model and Head Size, 2. Range, 3. Stem length, 4. Mounting Connection.

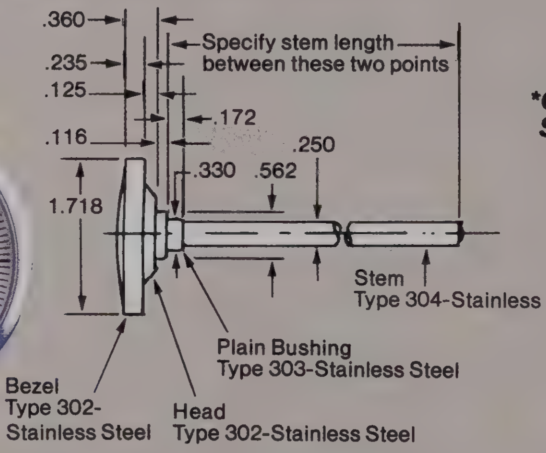
Model G

Made entirely of Stainless Steel except dial

Head 1¹¹⁄₁₆″ O.D. 9″ Stem Length Standard—other stem lengths available. See page S-9.
Normally supplied with plain bushing—Optional Threads ¼″ NPT, ½″ NPT, ⅜-24 NF

Ranges	°Divisions		
Fahrenheit			
25- 125°F	1°	*50- 300°F	2°
*−40- 160°F	2°	*50- 500°F	5°
*0- 200°F	2°	150- 750°F	10°
*0- 250°F	2°	200-1000°F	10°
−50- 300°F	10°		
Celsius			
*0-100°C	1°	0-150°C	1°
−10-110°C	1°	0-300°C	5°
***Dual Scale**			
50-300°F	2°	10-150°C	1°

**Off-the-Shelf Ranges*


.360
.235
.125
.116
Specify stem length between these two points
.172
.250
.330
.562
1.718
Stem Type 304-Stainless
Plain Bushing Type 303-Stainless Steel
Bezel Type 302-Stainless Steel
Head Type 302-Stainless Steel

$ 27

Order by specifying: 1. Model and Head Size, 2. Range, 3. Stem length, 4. Mounting Connection.

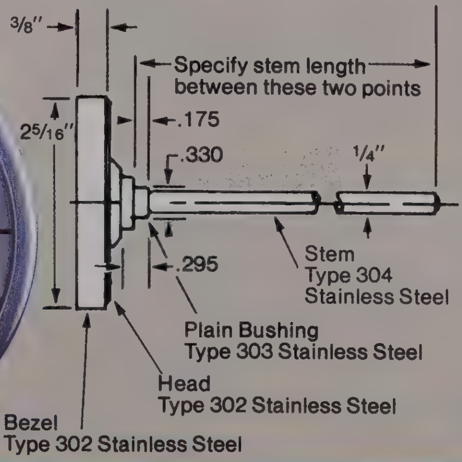
Model H

Made entirely of Stainless Steel except dial

Head 2⁵⁄₁₆″ O.D. 9″ Stem Length Standard — other stem lengths available. See page S-9.
Normally supplied with plain bushing — Optional Threads 1/4″ NPT, 1/2″ NPT, 3/8-24 NF

Ranges	°Divisions		
Fahrenheit			
25- 125°F	1°	*50- 300°F	2°
−40- 160°F	2°	*50- 500°F	5°
*0- 200°F	2°	*150- 750°F	10°
*0- 250°F	2°	*200-1000°F	10°
Celsius			
−40- 70°C	1°	0-150°C	1°
*0-100°C	1°	0-300°C	5°
−10-110°C	1°		

**Off-the-Shelf Ranges*


3/8″
Specify stem length between these two points
2⁵⁄₁₆″
.175
.330
1/4″
.295
Stem Type 304 Stainless Steel
Plain Bushing Type 303 Stainless Steel
Head Type 302 Stainless Steel
Bezel Type 302 Stainless Steel

$ 30

Order by specifying: 1. Model and Head Size, 2. Range, 3. Stem length, 4. Mounting Connection.

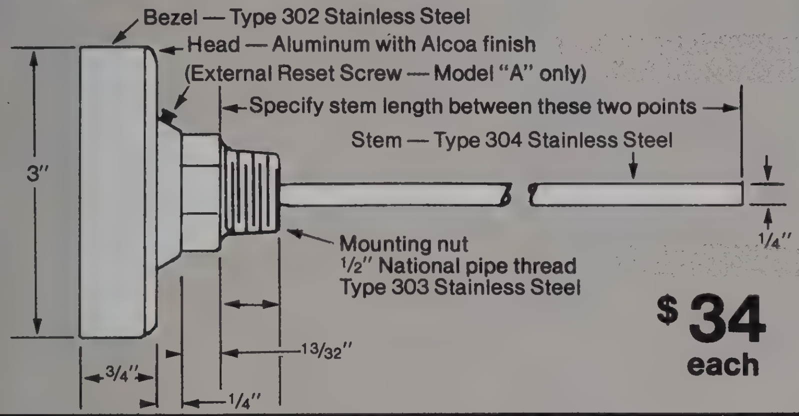
Models A and R

Made entirely of Stainless Steel except head and dial

Head 3" O.D. 9" Stem Length Standard—other stem lengths available. See page S-9.

Normally supplied with ½" NPT mtg. nut.
Optional: ¼" NPT, ¾" NPT, Hex Bushing

Model A has External Pointer Reset


Bezel — Type 302 Stainless Steel
Head — Aluminum with Alcoa finish
(External Reset Screw — Model "A" only)
Specify stem length between these two points
Stem — Type 304 Stainless Steel
3"
1/4"
Mounting nut
1/2" National pipe thread
Type 303 Stainless Steel
13/32"
3/4"
1/4"

$ 34
each

Ranges °Divisions					
Fahrenheit				**Celsius**	
0-100°F	1°	50- 400°F	5°	0- 50°C	½°
25-125°F	1°	50- 500°F	5°	*0-100°C	1°
–40-160°F	2°	250- 600°F	5°	–10-110°C	1°
*0-200°F	2°	150- 750°F	10°	0-150°C	1°
0-250°F	2°	200-1000°F	10°	0-200°C	2°
*50-300°F	2°			0-300°C	5°
Dual				100-500°C	5°
0-250°F	2°	50-500°F	2°		
–20+120°C	2°	10-260°C	2°		

***Off-the-Shelf Ranges**

250
300
200
350
150
400
100
°F
450
50
500
OMEGA

Order by specifying:
1. Model and Head Size, 2. Range, 3. Stem Length, 4. Mounting Nut.

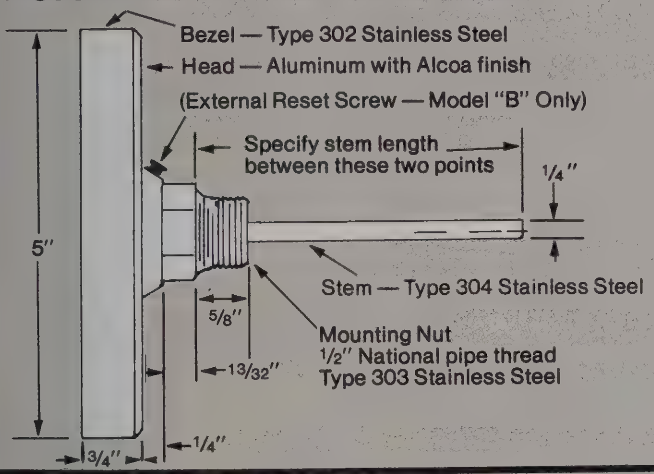
Models B and S

Made entirely of Stainless Steel except head and dial

Head 5" O.D. 9" Stem Length Standard—other stem lengths available. See page S-9.

Normally supplied with ½" NPT mtg. nut.
Optional: ¼" NPT, ¾" NPT, Hex Bushing

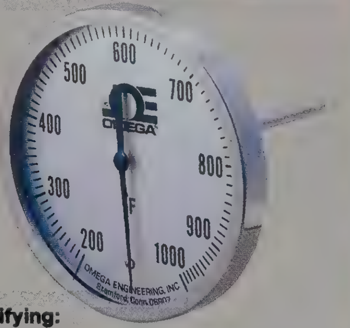
Model B has External Pointer Reset


Bezel — Type 302 Stainless Steel
Head — Aluminum with Alcoa finish
(External Reset Screw — Model "B" Only)
Specify stem length between these two points
1/4"
5"
Stem — Type 304 Stainless Steel
5/8"
Mounting Nut
1/2" National pipe thread
Type 303 Stainless Steel
13/32"
3/4"
1/4"

Ranges °Divisions			
Fahrenheit			
–40-160°F	2°	*50- 500°F	5°
*0-200°F	2°	150- 750°F	5°
*0-250°F	2°	200-1000°F	10°
*50-300°F	2°		
Celsius			
*0-100°C	1°	0-150°C	1°
–10-110°C	1°	0-300°C	5°

***Off-the-Shelf Ranges**

$ 45
each


600
500
700
400
OMEGA
800
300
F
900
200
1000
OMEGA ENGINEERING, INC.
Stamford, Conn. 06907

Order by specifying:
1. Model and Head Size, 2. Range, 3. Stem length, 4. Mounting Nut.

Thermometer Wells

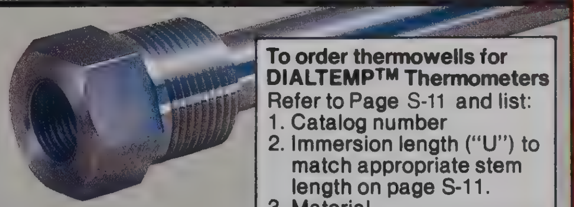
For ¼" Dia. Stems

Available in Brass, Carbon Steel, or Types 304 or 316 Stainless.

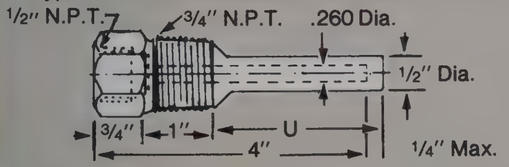
(Other materials on special order) See page S-11 when ordering.

External Thread – Standard: ¾" NPT **Optional:** 1" NPT

Thermowells make it possible to remove instruments without dropping pressure or losing contents. Each Thermowell die stamped with name and type of material from which it is made. Minimizes installation mixups.

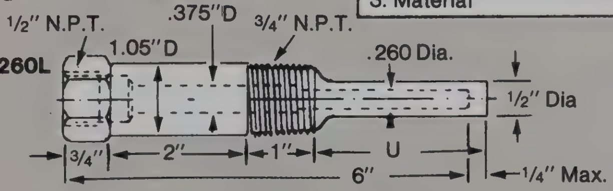


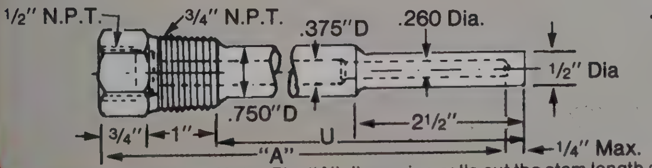
To order thermowells for DIALTEMP™ Thermometers
Refer to Page S-11 and list:
1. Catalog number
2. Immersion length ("U") to match appropriate stem length on page S-11.
3. Material


1/2" N.P.T.
3/4" N.P.T.
.260 Dia.
1/2" Dia.
3/4"
1"
U
4"
1/4" Max.

Type: ¾-260S

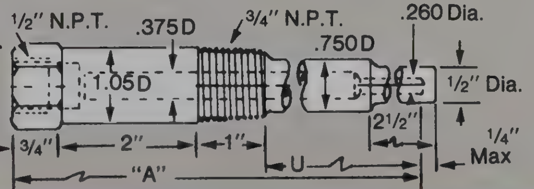
Type: ¾-260L


1/2" N.P.T.
.375"D
3/4" N.P.T.
1.05"D
.260 Dia.
1/2" Dia
3/4"
2"
1"
U
6"
1/4" Max.


1/2" N.P.T.
3/4" N.P.T.
.375"D
.260 Dia.
1/2" Dia
.750"D
3/4"
1"
U
2½"
"A"
1/4" Max.

Type: ¾-260S

Type: ¾-260L


1/2" N.P.T.
.375 D
3/4" N.P.T.
.260 Dia.
.750 D
1.05 D
1/2" Dia.
2½"
3/4"
2"
1"
U
1/4" Max
"A"

Note: The "A" dimension calls out the stem length as listed on page S-11. Use the catalog designation as called for — not the stem length in inches.

DialTemp™

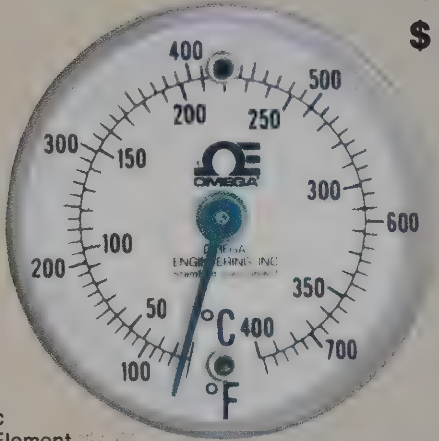
Surface Thermometers

Dual °F & °C Dials

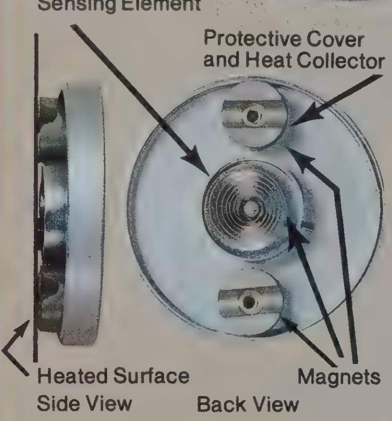
0° to 150°F **−20° to 65°C** (Model SUR-15)	***0° to 250°F** **−20°C to 120°C** (Model SUR-25)
0° to 500°F **−20° to 260°C** (Model SUR-50)	***50° to 750°F** **10° to 400°C** (Model SUR-75)

Price

$ 23



Bi-metallic Sensing Element



Specifications:

- **Head Size:** 2 inches (5.08 centimeters).
- **Height:** $1/2$ inch (1.27 centimeters)
- **Weight:** 2 ounces (56.7 grams) approx.
- **Dial:** white background, blue marks & numbers.
- **Case:** aluminum with optically clear crystal.
- **Sensing Element:** precision calibrated bi-metal coil.
- **Accuracy:** within 2% of full scale.
- **Response Time:** approximately 1 minute.
- **Mounting:** two magnets on back.

Operating Instructions:
This unique, handy little gage is great for use in sensing the temperature of almost any surface. The bi-metal sensing element is exposed to allow quick accurate response to surface temperature, but adequately shielded from damage by a protective cover and heat collector. For the most accurate reading this surface thermometer should be used in still air. Place the gage on the surface where you wish to know the temperature — dial face up with bi-metal sensing element against the surface. The magnets will allow placing in any position on a ferrous surface. It can also be used on any other material with a horizontal surface. Allow about a minute for the sensing element to stabilize and then read the temperature. Higher or lower air temperatures surrounding the thermometer or a draft over the surface may affect slightly the temperature indicated.

Some Typical applications: Air ducts, Boilers, Cabinets, Drums, Engines, Enclosures, Fire boxes, Manifolds, Platens, Plumbing, Piping, Refrigerators, and many, many others.

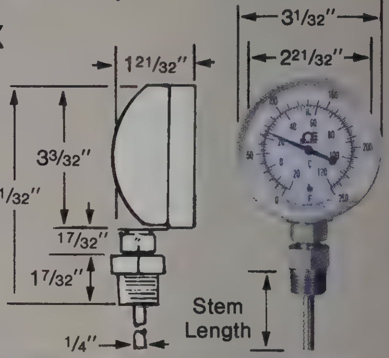
To order, specify model number.
***Available from stock**

Models X and V

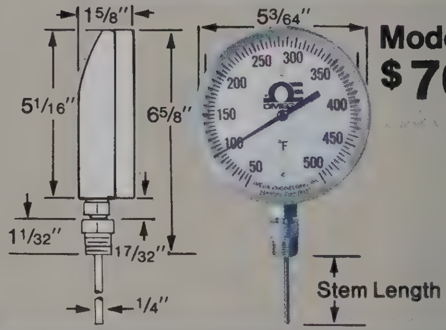
Heads: X-3″ O.D., V-5″ O.D. 9″ Stem Length Standard
Normally suppied with $1/2$″ NPT Mounting
Optional Thread $1/4$″ NPT or $3/4$″ NPT, Thread — $1/2$ NPT Mounting Thread
Made entirely of Stainless Steel except head and dial

Model X

$ 57



Model X Ranges °Divisions					
Fahrenheit				**Celsius**	
0-100°F	1°	50- 400°F	5°	0-100°C	1°
25-125°F	1°	50- 500°F	5°	−10-110°C	1°
−40-160°F	2°	250- 600°F	5°	0-150°C	1°
*0-200°F	2°	150- 750°F	10°	0-200°C	2°
*0-250°F	2°	200-1000°F	10°	0-300°C	5°
50-300°F	2°			100-500°C	5°
Dual					
0-250°F	2°	50-500°F	2°		
−20+120°C	2°	10-260°C	2°		



Model V

$ 70

Model V Ranges °Divisions					
Fahrenheit				**Celsius**	
−40-160°F	2°	50- 500°F	5°	0-100°C	1°
0-200°F	2°	150- 750°F	5°	−10-110°C	1°
0-250°F	2°	200-1000°F	10°	0-150°C	1°
50-300°F	2°			0-300°C	5°

Thermometers of this design are well adapted to installations on top of tanks, boilers, in high locations or other areas where it would be difficult to read the standard ANGLE form instrument.

Heads are made as a heavy die casting from Zamac #5 alloy. They are chromium plated and polished. Bezel is type 302 stainless steel being polished to match the attractive head.

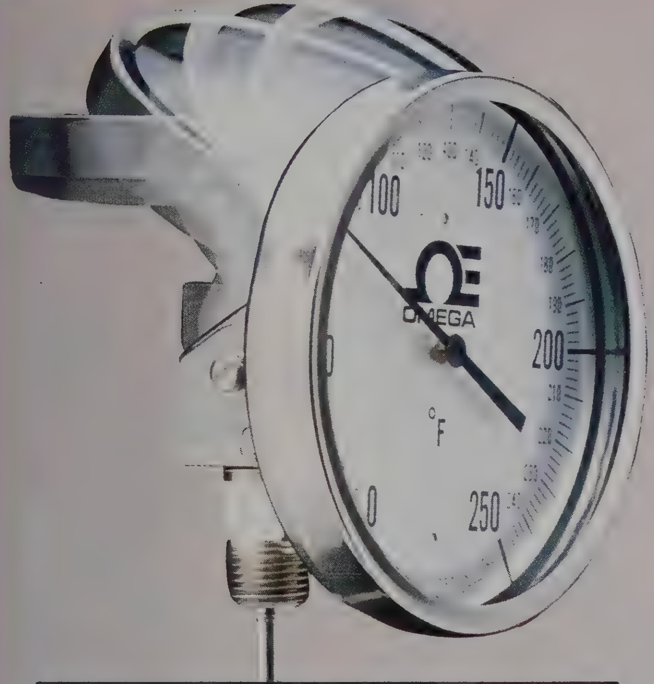
Stems for the Model X and V are $1/4$″ in diameter. Stem lengths up to 36″ can be supplied.

An outstanding feature of the straight form model is the ADJUSTABLE $1/2$″ N.P.T. mounting nut which is standard on the X and V series. This makes it possible to turn the head a full 360° clockwise or counter-clockwise and to then LOCK it in the exact position desired for maximum visibility.

Although the Models X and V are normally supplied with the stem at the BOTTOM (6 o'clock) position, on special order can be set with the stem protruding at the LEFT (9 o'clock), TOP (12 o'clock) or RIGHT (3 o'clock) positions. If not specified, the standard BOTTOM (6 o'clock) position will be supplied.

Order by specifying: 1. Model and Dial Size; 2. Range; 3. Stem Length; 4. Mounting Nut

DialTemp™ Model "J" Bi-metal Thermometer

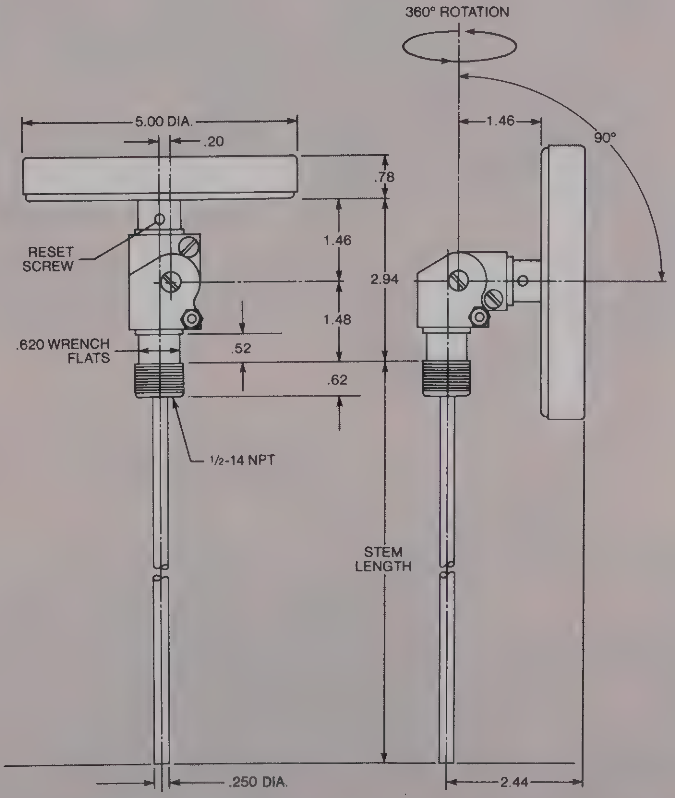


The Model "J" DialTemp™ bi-metal thermometer features a swivel neck which allows the large 5 inch dial to be set at any angle within its full 90° tilt range. Further, the head can also be turned through a full 360°. The extent of the tilt and rotational adjustment are shown in the diagram below. This feature solves many problems in improving dial readability in many installations. With the Model "J", its simple—just set the head angle to the position where the user can see it best.

OMEGA's rugged Model "J" DialTemp™ thermometers are manufactured from stainless steel welded construction. The ¼-inch diameter probe is supplied with a ½-inch NPT fitting, making Model "J" thermometers compatible with standard thermowell designs. The standard stem length is 6 inches. Other available stem lengths are shown in the table at left.

To order, specify Model "J" followed by the range and stem length.

Price for 2½ and 6-inch stem lengths: **$82**



STEM LENGTHS

Standard: 2½", 6"

Also available: 4", 9", 12", 15", 18", 24", 30", 36"

Intermediate lengths available on special order.

RANGES & DIVISIONS

Fahrenheit		Celsius	
-40- 160°F	2°	0-100°C	1°
* 0- 200°F	2°	-10-110°C	1°
* 0- 250°F	2°	0-150°C	1°
50- 300°F	2°	* 0-300°C	5°
* 50- 500°F	5°		
150- 750°F	5°		
100- 800°F	5°		
200-1000°F	10°		

*Off-the-Shelf Ranges: 2½", 6" STEM LENGTHS.

Not recommended for continuous use above 800°F.
Order by specifying:
1. Model 2. Range 3. Stem Length

Features

- **Head may be tilt-adjusted through a full 90° angle.**
- **All stainless steel welded construction.**
- **External recalibration.**
- **Rust and corrosion-proof, leakproof, hermetically sealed.**
- **Sensitive bi-metal element silicone dampened for minimum pointer vibration and maximum heat transfer.**
- **Accuracy — 1% of range.**
- **Rated to 1,000 psi. Use of thermowell is recommended for higher pressures or for very heavy-duty applications.**
- **Overrange protection — 50% up to 500°F.**

Price List

Bimetal Dial Thermometers

Angle form—Back connected

MOST POPULAR STEM LENGTHS ▼ 9″

Stem lengths (inches)		**2½″**	**4″**	**6″**	**9″**	**12″**	**15″**	**18″**	**24″**	**30″**	**36″**
Model Q 1 5/32″ O.D. Head (See Page S-5) With Plain Bushing		$22	$22	$22	$25	$29	$30	$31	$34	$37	$40
with ¼″ NPT MTG. THD.		24	24	24	27	31	32	33	36	39	42
with ⅜″-24NF MTG. THD.		24	24	24	27	31	33	34	37	40	43
with ½″ NPT MTG. THD.		25	25	25	29	32	33	34	37	40	43
Model G 1 11/16″ O.D. Head	**STEM**	**2½″**	**4″**	**6″**	**9″**	**12″**	**15″**	**18″**	**24″**	**30″**	**36″**
(See Page S-5) With Plain Bushing		24	24	24	27	31	32	33	36	39	42
with ¼″ NPT MTG. THD.		25	25	25	29	33	34	35	38	41	44
with ⅜″-24NF MTG. THD.		26	26	26	30	33	35	36	38	41	45
with ½″ NPT MTG. THD.		26	26	26	30	33	35	36	39	42	45
Model H 2 5/16″ O.D. Head	**STEM**	**2½″**	**4″**	**6″**	**9″**	**12″**	**15″**	**18″**	**24″**	**30″**	**36″**
(See Page S-5) With Plain Bushing		26	26	26	30	33	33	34	37	40	43
with ¼″ NPT MTG. THD.		29	29	29	31	33	35	36	40	42	45
with ⅜″-24NF MTG. THD.		29	29	29	31	34	36	37	40	43	46
with ½″ NPT MTG. THD.		30	30	30	32	38	38	38	40	43	46
Models G & H with External MTG. Brackets	**STEM**	**2½″**	**4″**	**6″**	**9″**	**12″**					
(See Page S-5) G/EMB 1 11/16″ O.D. Head		31	31	31	33	35	OVER 12″ NOT RECOMMENDED				
H/EMB 2 5/16″ O.D. Head		33	33	33	34	37	OVER 12″ NOT RECOMMENDED				
Models A & R 3″ O.D. Head	**STEM**	**2½″**	**4″**	**6″**	**9″**	**12″**	**15″**	**18″**	**24″**	**30″**	**36″**
(See Page S-6) "A" with External Reset, ½″ NPT		31	31	31	34	37	39	40	42	46	50
"R" with ½″ NPT MTG. THD.		31	31	31	34	37	38	39	41	45	49
Models B & S 5″ O.D. Head	**STEM**	**2½″**	**4″**	**6″**	**9″**	**12″**	**15″**	**18″**	**24″**	**30″**	**36″**
(See Page S-6) "B" with External Reset, ½″ NPT		42	42	42	46	49	52	53	56	61	67
"S" with ½″ NPT MTG. THD.		42	42	42	45	48	51	52	55	60	66
Model J 5″ O.D. Head (See Page S-8)		82	82	82	85	92	94	101	110	125	140

Straight form—Bottom connected

Stem lengths (inches)	**2½″**	**4″**	**6″**	**9″**	**12″**	**15″**	**18″**	**24″**	**30″**	**36″**
Model X 3″ O.D. Head with ½″ NPT MTG. THD. (See Page S-7)	56	56	56	57	67	67	71	NOT RECOMMENDED		
Model V 5″ O.D. Head with ½″ NPT MTG. THD. (See Page S-7)	67	67	67	70	78	78	85	NOT RECOMMENDED		

For intermediate stem lengths add $3 to next longer standard stem length.
Stems over 36″ are available on Models Q, G, H, A, R, B and S—Consult Sales Department for pricing.

Optional mounting threads for Models A, R, B, S, X, and V not listed above.

¼″ NPT Mounting nut add $3 to unit price.
¾″ NPT Mounting nut add $6 to unit price.
½″ NPT Type 316 S.S. MTG. nut add $22 to unit price.
or ¾″ NPT Type 316 S.S. MTG. nut add $22 to unit price.

Plain hex bushing—No additional charge
Special mounting threads—Prices on application

Optional mounting threads for Models Q, G, and H not listed above.
⅛″ NPT and ⅜″ NPT MTG. Thds. add $6.
Design and specs subject to change as engineering improvement permits

Accessories and Optional Features

Mounting Threads and Bushings

¼″ NPT — Available on all Models
½″ NPT — Available on all Models
¾″ NPT — Models A, R, B, S, X, V.
⅜″ NPT — Models Q,G,H.

Hex bushing Models A,R,B, S,X,V.

Other **threads** on Special Order.

External Mounting Brackets

70
80
60
90
50
100
40
110
30
120
°F
OMEGA
OMEGA ENGINEERING INC
Stamford Conn 06907

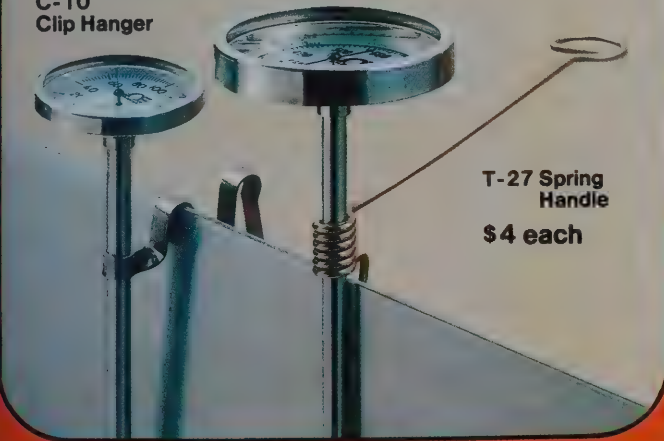
External Mounting Brackets are optionally available from stock on the Models "G" and "H" only. These Brackets facilitate surface mounting on cabinets, ovens, coolers, instrument panels and various other enclosures or flat surfaces.

Clip Hanger and Spring Handle

The C-10 Clip Hanger and T-27 Spring Handle are pictured below. They are used on the rim of tanks, kettles, urns, solder pots, beakers or other containers. The Spring Handle (T-27) can be hand held allowing thermometer insertion in hot or corrosive materials without exposure of the hand. Very handy items. Available from stock.

- POINTED STEMS — All Models. — **$3 each**
- Pocket Case/Clip — for 5″ or 6″ Stems only. — **$4 each**
- Unbreakable Clear Plastic Crystals — **$4 each**
- Hi-Temperature Crystal — Model Q only. — **$5 each**
- Custom Dials to your specifications.
- Custom Mounting Fixtures or Adaptors.
- Special Temperature Ranges
- Custom Thermometers

Consult Sales Department for price & delivery.



C-10 Clip Hanger

T-27 Spring Handle

$4 each

Engineering Specifications

Materials

Stems:

All Models, Type 304 Stainless Steel (highly resistant to corrosion). STANDARD lengths — 2½″, 4″, 6″, 9″, 12″, 15″, 18″, 24″, 30″, 36″. OPTIONAL: Intermediate, or to 80″ on the Angle Form (Back Connected) only. Please note that a 4″ Stem is the shortest length for ranges 0-100°F, 25-125°F and 0-50°C. The 9″ length is the most popular and stocked for immediate delivery. Allow 3 weeks for special lengths.

Heads:

Models QP, GL, HL, T, Q, G, H, G/EMB and H/EMB are polished Type 302 Stainless Steel. Models A, B, R, & S are polished Satin finished Anodized Aluminum. Models X & V are Die cast, Zamac No. 5 polished and heavy chrome plated.

Bezels:

All Models, polished Type 302 Stainless Steel.

Mounting Bushings and Nuts:

All Models, Type 303 Stainless Steel (Type 316 optional on Models A, B, R, S, X and V — ½″ NPT.) See page S-9. Other materials on special application with minimum quantity requirement.

Crystals:

Optically clear strong glass. OPTIONAL: Unbreakable clear plastic, all Models except Q and QP (not recommended for ranges over 300°F).

Dials:

Double anodized aluminum. Raised black marks and numbers with satin matte finish background. Easy to read. Minimum Parallax.

Angle Form (back connected):

MODELS Q, G, H, A, R, B, S, QP, GL, HL, T, G/EMB and H/EMB.

Straight form (bottom connected):

MODELS X and V. An outstanding feature of the DialTemp™ Straight Form thermometers is the adjustable Mounting Nut which makes it possible to turn the head a full 360° on the stem axis and then lock it in the exact position desired for maximum visibility.

Accuracy:

All Models are accurate to within plus or minus 1% of the full scale.

Pointed stems:

Optional on all models. Excellent for probing asphalt, compost, soil, frozen foods or other semi-solid materials.

Mounting connections:

STANDARD on Models QP, GL, HL, Q, G, H, and T is a Plain Bushing. STANDARD on the Models A, R, B, S, X, and V is the ½″ NPT Mounting Thread. STANDARD on the Models G/EMB and H/EMB are Stainless Steel "ears" at 3 and 9 o'clock with .144 Diameter screw hole. OPTIONAL threads are available, see page S-9. Allow extra time for any optional mounting connections. Consult factory for price & delivery.

Maximum Temperature and Pressure Ratings:

The maximum pressure rating on all DialTemp™ thermometers is 1000 psi. The maximum ambient temperature for the entire assembly is 300°F. The ambient temperature with a plastic lens is 200°F. This does not apply to the K-79 pocket thermometers — they are not rated for pressure.

Engineering Specifications *(Continued)*

Temperature ranges:

FAHRENHEIT; 0 to 100°F, 25 to 125°F, –40 to 160°F, 0 to 200°F, 0 to 250°F, –50 to 300°F, 50 to 300°F, 50 to 400°F, 50 to 500°F, 250 to 600°F, 150 to 750°F, 200 to 1000°F.
CELSIUS: 0 to 50°C, –40 to 70°C, 0 to 100°C, –10 to 110°C, 0 to 150°C, 0 to 200°C, 0 to 300°C, 100 to 500°C.
Other ranges are available upon special order with minimum quantity requirement. (Please note — for ranges 0-100°F, 25-125°F and 0-50°C shortest stem length is 4 inches.) Select most common ranges for "off-the-shelf" delivery.

O.E.M. applications:

If you are an Original Equipment Manufacturer and plan to incorporate the DialTemp™ Thermometer in your finished product for resale, special ranges or special dials can be made to suit your particular requirements. Such specials can bear your own company name and/or trade-mark on the dial, but a minimum quantity order must be placed. For full information, please write giving desired range, dial size, stem length, mounting connection, and your special requirements. We will be happy to quote. Any DialTemp™ thermometer will complement your equipment, for its quality, appearance and performance is unsurpassed.

External reset:

The Models A and B (see page S-6) are equipped with an external reset screw; a hex key to fit it is furnished with each unit. This allows resetting the pointer without removing the bezel or disassembling the unit.

Immersion:

For correct temperature measurement the stem of all Models in all ranges must be immersed at least 2 inches in liquids, and 4 inches in gas except for 0 to 100°F, 24° to 125°F, and 0 to 50°C which require at least 3 1/2 inches in liquid and 5 inches in gas. The most common immersion length is 9 inches; these are stocked for "off-the-shelf" delivery in popular ranges. Prices are given for popular-stock ranges. Other stem lengths, consult Sales Department for price & delivery

Ordering Instructions

When ordering your DialTemp™ Bi-metal Thermometer select stock or standard models for fast delivery.

Order by specifying

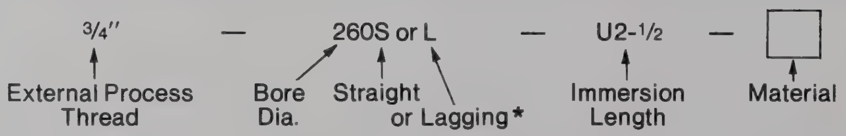
1. Model and Head size
2. Temperature Range
3. Stem Length
4. Mounting Nut or Bushing

For convenience and fast delivery certain "common ranges" and configurations should be used wherever possible. See below:

- Except for Models K-79, QP, GL, HL and T, the most popular stem length is 9 inches.
- The Models QP and K-79 stem lengths are 5 inches.
- The Models GL and HL and T stem lengths are 8 inches.
- The Model T stem length is 8-5/32 inches.
- The following ranges are the most popular in all models.

0-200°F	50-300°F	50-500°F	150-750°F
0-250°F	25-125°F	–40-160°F	0-100°C

Thermowells for Dial Temp™ Thermometers



Thermowell Catalog Number	Dial Temp™ Stem Length	Material Selection**			
		Brass	Carbon Steel	304SS	316SS
3/4"-260A-U1 5/8-☐	2 1/2"	$14.00	$14.00	$ 20.00	$ 27.00
3/4"-260S-U2-1/2-☐	4"	16.50	16.50	22.00	30.00
3/4"-260L*-U2-1/2-☐	6"	20.00	20.00	26.50	36.00
3/4"-260L -U4-1/2-☐	9"	31.50	31.50	39.50	53.00
3/4"-260L-U7-1/2-☐	12"	41.00	41.00	48.00	65.00
3/4"-260L-U10-1/2-☐	15"	53.00	53.00	69.00	93.00
3/4"-260L-U13-1/2-☐	18"	63.50	63.50	82.50	111.00
3/4"-260L-U19-1/2-☐	24"	74.00	74.00	106.00	143.00

*2" lagging extension all other 3" standard.

**Other materials available, consult Sales Department.

WHEN ORDERING THERMOWELL AND DIAL TEMP™ ASSEMBLIES PLEASE SPECIFY:

1. THERMOWELL CATALOG NUMBER
2. IMMERSION LENGTH — "U" DIMENSION IN INCHES
3. MATERIAL
4. DIAL TEMP™ THERMOMETER MODEL AND HEAD SIZE
5. TEMPERATURE RANGE
6. APPROPRIATE STEM LENGTH FOR WELL SELECTED
7. MOUNTING NUT — 1/2"NPT IS STANDARD

DialTemp™ Features

Excellence in a product never occurs by mere chance. It is the result of constant striving for perfection in the little things as well as the big. That is why OMEGA's Stainless Steel Dial Thermometers are used by industries, laboratories, processors, universities and governments the world over. Easy to read dials, rugged construction, leak proof heliarc welds and guaranteed accuracy assures the discriminating buyer of the finest thermometer which, incidentally, is easily within reach of even the most modest budget. Available in a wide variety of dial sizes, stem lengths, temperature ranges and mounting connections, OMEGA thermometers offer the user much flexibility in selecting just the right configuration to meet virtually every temperature measuring requirement. These accurate thermometers have been manufactured to the very highest standard of excellence by expert craftsmen using the finest materials available. An OMEGA stainless steel thermometer is a lasting investment value in scientific termperature measurement.

Precision built for lifetime service. Critical assembly points in the DialTemp™ Thermometer are heliarc welded. No brazing metal is added. Stainless steel stem, plugs and mounting nuts are actually fused together to form a perfect moisture-proof bond. No possibility of rust or corrosion setting in! The very highly corrosion resistant type 304 Stainless Steel is used for all stems in every DialTemp™ thermometer listed in this handbook. Each thermometer is meticulously manufactured step by step to produce a most efficient precision thermometer. Bi-metal coils are wound to pre-determined standards and are individually trimmed and tested, one by one, until they provide the exact amount of rotation required for an accurate full scale reading. OMEGA provides an instrument far above the average in ruggedness, dependability and accuracy!

Easy to read. Clear, crisp, raised marks and numbers on the dial provide exceptional readability with this "pointer to dial" method of indication. The double anodized aluminum dials with satin matte finish background and black raised marks and numbers assure minimum parallax.

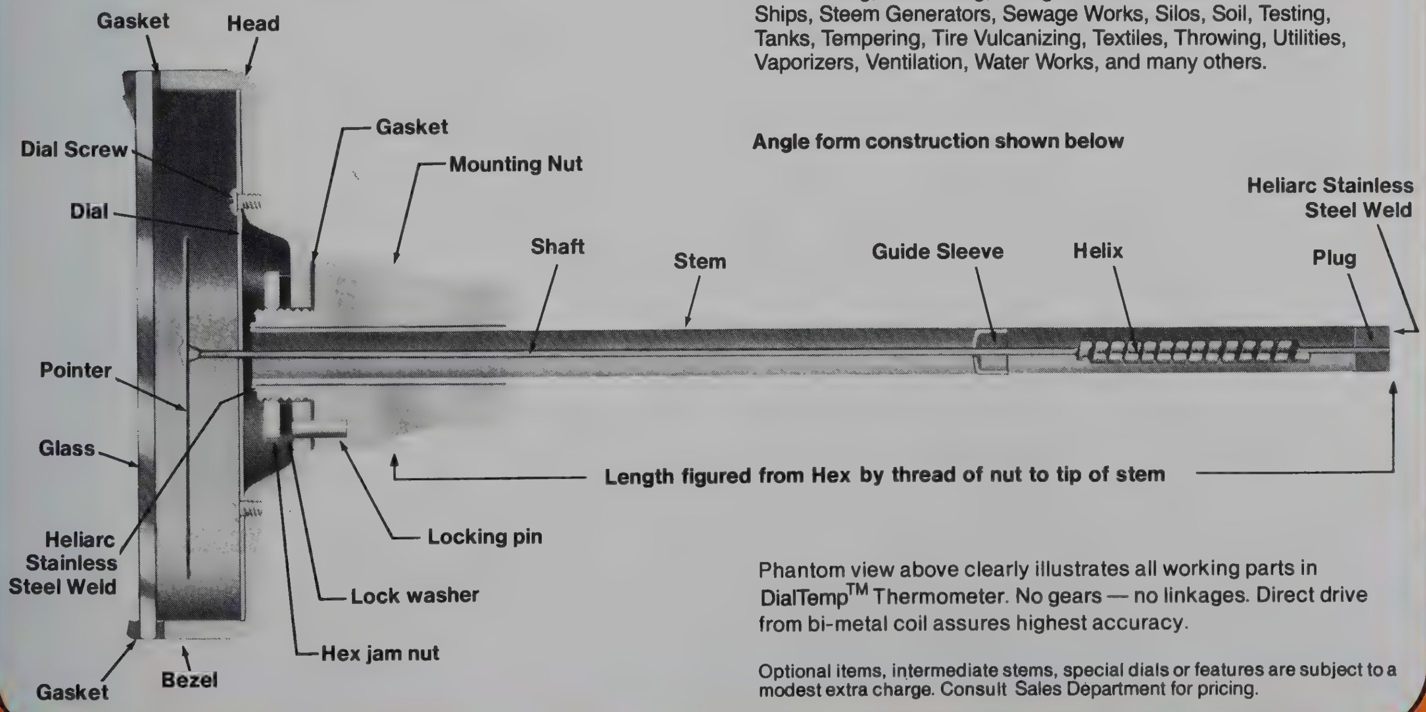
Rugged and Reliable. The all metal construction, except for the optically clear crystal of DialTemp™ thermometers and their heliarc welded fabrication make them virtually unbreakable. The type 304 Stainless Steel stems offer exceptional protection against highly corrosive materials. The bi-metal principle of temperature measurement eliminates the need for gas, vapor, mercury, alcohol, or capillary tubing. With no gears or linkage to impede movement, the direct drive from helix coil to pointer gives an accurate indication every time. No parts to wear out or fail, no leakage or fluid column separation and no glass tube breakage.

Accurately calibrated. The most precise calibrating methods are used in the fabrication, calibrating and testing of each sensing helix coil before it goes into an OMEGA thermometer. Each thermometer is then individually calibrated for maximum accuracy. All calibration is performed to instrumentation which has been calibrated to standards traceable to the National Bureau of Standards. Each thermometer must meet an accuracy tolerance within 1% of the range over the full scale. This high degree of perfection is achieved by using bi-metal materials manufactured and fabricated under near laboratory conditions. Experienced craftsmen and engineers insure precise production of each unit in every phase of manufacturing. As a final check, each instrument is given a complete heat test before it is packed eliminating any chance for error. DialTemp™ thermometers read right because they are right!

Protected against temperature over-range. Occasionally operating temperatures may accidentally exceed the range of the thermometer. This, however, will not harm its accuracy. The precision bi-metal coils, which transform heat into pointer motion, will withstand a 50% over-range on instruments up to and including 500°F. A 10% over-range is permissible on higher temperature ranges. Under-ranging within the 50% limit on all ranges will also not harm its accuracy.

Plus advantages. DialTemp™ metal thermometers have certain obvious advantages over conventional glass units. For example, they are virtually unbreakable. The dial and pointer principle is far easier to read at a glance. Long stem models can be immersed in deep vats or tanks where there is a variation between top and bottom temperatures. Stainless steel is easy to clean. In addition, the DialTemp™ thermometer can be plunged directly into molten lead or babbit. Temperature readings are stabilized within 40 seconds or less. All in all, regardless of the application, these rugged units reveal temperatures easier, faster and with greater dependability.

Applications and Usage. (Partial List) Air Conditioning, Asphalt, Boilers, Baking, Burners, Cabinets, Chemicals, Cookers, Coolers, Coffee Urns, Canning, Concrete, Dairies, Ducts, Dyeing Equipment, Developers, Dehydrators, Engines, Extruders, Enclosures, Grain Elevators, Furnaces, Fire Boxes, Food Processors, Greenhouses, Glue Machines, Heaters, Heat Exchangers, Incinerators, Instrument Panels, Impregnating Tanks, Incubators, Kidney Machines, Laboratories, Lumber Mills, Manifold, Marine, Metallurgy, Milling, Mineralogy, Platens, Processing, Plastics, Plating, Petroleum, Petrochemical, Pharmaceuticals, Photography, Plumbing, Pickling, Piping, Pulp, Pasteurizing, Quenching, Refrigeration, Refineries, Solder, Stacks, Ships, Steem Generators, Sewage Works, Silos, Soil, Testing, Tanks, Tempering, Tire Vulcanizing, Textiles, Throwing, Utilities, Vaporizers, Ventilation, Water Works, and many others.


Gasket
Head
Dial Screw
Dial
Gasket
Mounting Nut
Angle form construction shown below
Heliarc Stainless Steel Weld
Shaft
Stem
Guide Sleeve
Helix
Plug
Pointer
Glass
Length figured from Hex by thread of nut to tip of stem
Heliarc Stainless Steel Weld
Locking pin
Lock washer
Hex jam nut
Gasket
Bezel

Phantom view above clearly illustrates all working parts in DialTemp™ Thermometer. No gears — no linkages. Direct drive from bi-metal coil assures highest accuracy.

Optional items, intermediate stems, special dials or features are subject to a modest extra charge. Consult Sales Department for pricing.

76 °F
OMEGA
OMEGA
105.21
OMEGA
999
OMEGA
°C
MODEL 727C
THERMOCOUPLE THERMOMETER
TYPE K CHROMEL-ALUMEL
RANGE -50°C to +800°C
OMEGA ENGINEERING INC.
°F
MODEL 727F
THERMOCOUPLE THERMOMETER
TYPE K CHROMEL-ALUMEL
RANGE -50°F to +999°F
OMEGA ENGINEERING INC.
THERMOCOUPLE REFERENCE TABLES
based on the IPTS-68
NBS MONOGRAPH 125
OMEGA-CJ
OMEGA

T

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Type	Scale	
J	°C	T-41
K	°C	T-42
E	°C	T-44
T	°C	T-45
S	°C	T-46
R	°C	T-48
B	°C	T-50
J	°F	T-52
K	°F	T-54
E	°F	T-57
T	°F	T-59
S	°F	T-61
R	°F	T-64
B	°F	T-67
G,C,D	°C	T-70
RTD	α = .00385	T-71
	α = .00392	T-74

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Emissivity T-78

Now Available!

Five of the Most Useful and Needed Books on Temperature Measurement

from OMEGA PRESS

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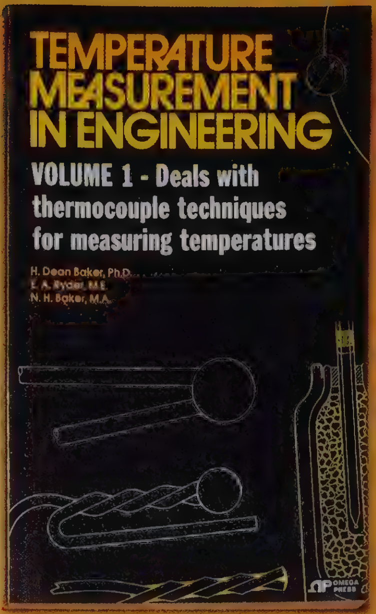

TEMPERATURE MEASUREMENT IN ENGINEERING
VOLUME 1 - Deals with thermocouple techniques for measuring temperatures
H. Dean Baker, Ph.D.
E. A. Ryder, M.E.
N. H. Baker, M.A.
OMEGA PRESS

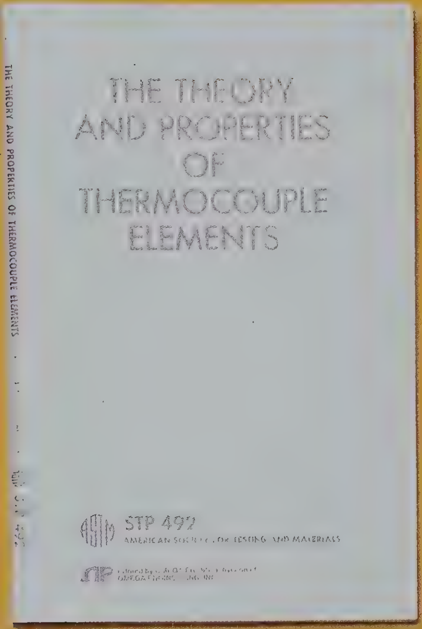
TEMPERATURE MEASUREMENT IN ENGINEERING, VOLUME 1

published by OMEGA PRESS

This book, written by H. Dean Baker, E.A. Ryder, N.H. Baker, is the first of a 2-volume work and provides for a convenient source of information necessary to the engineer who wishes to measure temperature. Volume 1 as well as Volume 2 are now considered classics in temperature measurement and should be on the shelf of every serious temperature measurement researcher or engineer.

Volume 1 is a compact book intended for convenient reference and contains much material of practical importance in temperature measurement. Stress is placed in this book on specific procedures and techniques involved in producing satisfactory temperature measurement designs for various circumstances. This volume deals primarily with thermocouple technique.

CATALOG NO. OP-1 . . . $7


THE THEORY AND PROPERTIES OF THERMOCOUPLE ELEMENTS
STP 492
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THE THEORY AND PROPERTIES OF THERMOCOUPLE ELEMENTS

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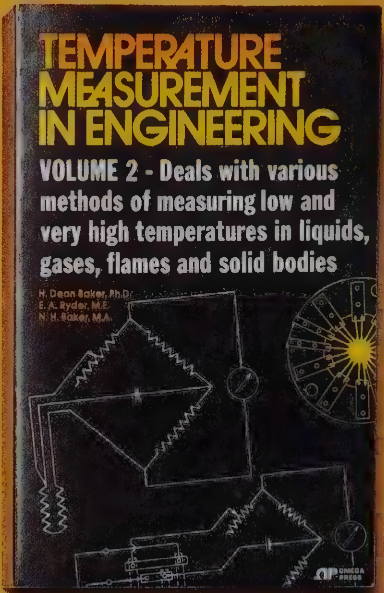
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VOLUME 2 - Deals with various methods of measuring low and very high temperatures in liquids, gases, flames and solid bodies
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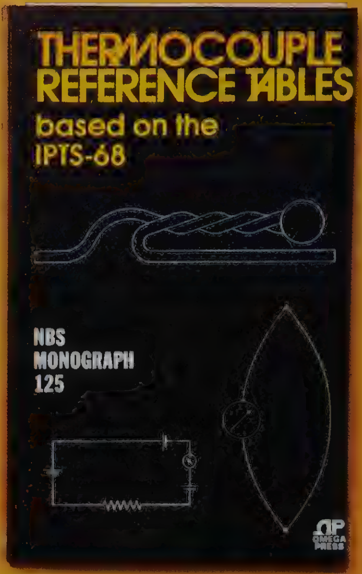
THERMOCOUPLE REFERENCE TABLES
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	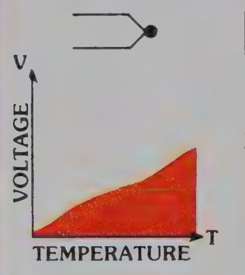	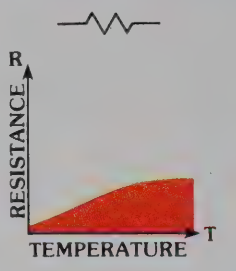	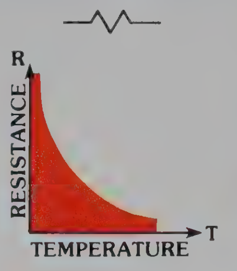	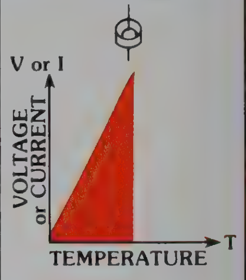
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Figure 1

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INTRODUCTION

Synthetic fuel research, solar energy conversion and new engine development are but a few of the burgeoning disciplines responding to the state of our dwindling natural resources. As all industries place new emphasis on energy efficiency, the fundamental measurement of temperature assumes new importance. The purpose of this application note is to explore the more common temperature monitoring techniques and introduce procedures for improving their accuracy.

We will focus on the four most common temerature transducers: the thermocouple, the RTD, the thermistor and the integrated circuit sensor. Despite the widespread popularity of the thermocouple, it is frequently misused. For this reason, we will concentrate primarily on thermocouple measurement techniques.

Appendix A contains the empirical laws of thermocouples which are the basis for all derivations used herein. Readers wishing a more thorough discussion of thermocouple theory are invited to read REFERENCE 17 in the Bibliography.

For those with a specific thermocouple application, Appendix B may aid in choosing the best type of thermocouple.

Throughout this application note, we will emphasize the *practical* considerations of transducer placement, signal conditioning and instrumentation.

Early Measuring Devices – Galileo is credited with inventing the thermometer, circa 1592.[1,2,3] In an open container filled with colored alcohol he suspended a long narrow-throated glass tube, at the upper end of which was a hollow sphere. When heated, the air in the sphere expanded and bubbled through the liquid. Cooling the sphere caused the liquid to move up the tube.[1] Fluctuations in the temperature of the sphere could then be observed by noting the position of the liquid inside the tube. This "upside-down" thermometer was a poor indicator since the level changed with barometric pressure and the tube had no scale. Vast improvements were made in temperature measurement accuracy with the development of the Florentine thermometer, which incorporated sealed construction and a graduated scale.

In the ensuing decades, many thermometric scales were conceived, all based on two or more fixed points. One scale, however, wasn't universally recognized until the early 1700's, when Gabriel Fahrenheit, a Dutch instrument maker, produced accurate and repeatable mercury thermometers. For the fixed point on the low end of his temperature scale, Fahrenheit used a mixture of ice water and salt (or ammonium chloride). This was the lowest temperature he could reproduce, and he labeled it "zero degrees". For the high end of his scale, he chose human blood temperature and called it 96 degrees.

Why 96 and not 100 degrees? Earlier scales had been divided into twelve parts. Fahrenheit, in an apparent quest for more resolution divided his scale into 24, then 48 and eventually 96 parts.

The Fahrenheit scale gained popularity primarily because of the repeatability and quality of the thermometers that Fahrenheit built.

Around 1742, Anders Celsius proposed that the melting point of ice and the boiling point of water be used for the two benchmarks. Celsius selected zero degrees as the *boiling* point and 100 degrees as the melting point. Later, the end points were reversed and the centigrade scale was born. In 1948 the name was officially changed to the Celsius scale.

In the early 1800's William Thomson (Lord Kelvin), developed a universal thermodynamic scale based upon the coefficient of expansion of an ideal gas. Kelvin established the concept of absolute zero and his scale remains the standard for modern thermometry.

The conversion equations for the four modern temperature scales are:

$$°C = 5/9\ (°F - 32) \qquad °F = 9/5\ °C + 32$$

$$K = °C + 273.15 \qquad °R = °F + 459.67$$

The Rankine Scale (°R) is simply the Fahrenheit equivalent of the Kelvin scale, and was named after an early pioneer in the field of thermodynamics, W.J.M. Rankine.

[1,2,3] Refer to Bibliography 1,2,3.

Reference Temperatures

We cannot build a temperature divider as we can a voltage divider, nor can we add temperatures as we would add lengths to measure distance. We must rely upon temperatures established by physical phenomena which are easily observed and consistent in nature. The International Practical Temperature Scale (IPTS) is based on such phenomena. Revised in 1968, it establishes eleven reference temperatures.

Since we have only these fixed temperatures to use as a reference, we must use instruments to interpolate between them. But accurately interpolating between these temperatures can require some fairly exotic transducers, many of which are too complicated or expensive to use in a practical situation. We shall limit our discussion to the four most common temperature transducers: thermocouples, resistance-temperature detector's (RTD's), thermistors, and integrated circuit sensors.

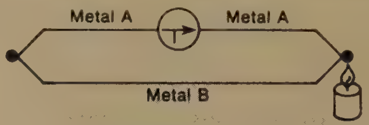
IPTS-68 REFERENCE TEMPERATURES

EQUILIBRIUM POINT	K	°C
Triple Point of Hydrogen	13.81	−259.34
Liquid/Vapor Phase of Hydrogen at 25/76 Std. Atmosphere	17.042	−256.108
Boiling Point of Hydrogen	20.28	−252.87
Boiling Point of Neon	27.102	−246.048
Triple Point of Oxygen	54.361	−218.789
Boiling Point of Oxygen	90.188	−182.962
Triple Point of Water	273.16	.01
Boiling Point of Water	373.15	100
Freezing Point of Zinc	692.73	419.58
Freezing Point of Silver	1235.08	961.93
Freezing Point of Gold	1337.58	1064.43

Table 1

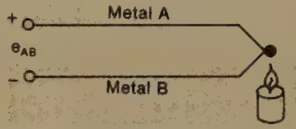
THE THERMOCOUPLE

When two wires composed of dissimilar metals are joined at both ends and one of the ends is heated, there is a continuous current which flows in the *thermoelectric* circuit. Thomas Seebeck made this discovery in 1821.



THE SEEBECK EFFECT
Figure 2

If this circuit is broken at the center, the net open circuit voltage (the Seebeck voltage) is a function of the junction temperature and the composition of the two metals.



e_{AB} = SEEBECK VOLTAGE
Figure 3

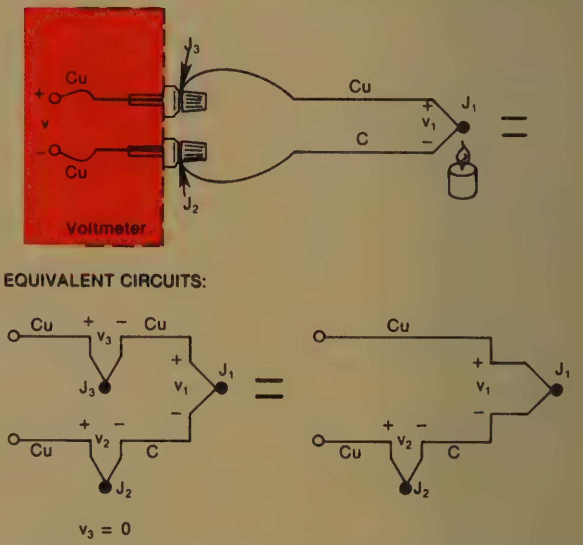
All dissimilar metals exhibit this effect. The most common combinations of two metals are listed on the inside cover of this application note, along with their important characteristics. For small changes in temperature the Seebeck voltage is linearly proportional to temperature:

$$e_{AB} = \alpha T$$

Where α, the Seebeck coefficient, is the constant of proportionality.

Measuring Thermocouple Voltage – We can't measure the Seebeck voltage directly because we must first connect a voltmeter to the thermocouple, and the voltmeter leads themselves create a new thermoelectric circuit.

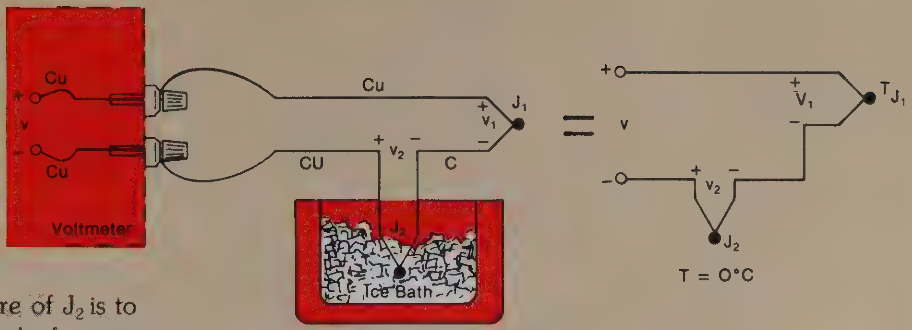
Let's connect a voltmeter across a copper-constantan (Type T) thermocouple and look at the voltage output:



MEASURING JUNCTION VOLTAGE WITH A DVM
Figure 4

We would like the voltmeter to read only V_1, but by connecting the voltmeter in an attempt to measure the output of Junction J_1, we have created two more metallic junctions: J_2 and J_3. Since J_3 is a copper-to-copper junction, it creates no thermal EMF ($V_3 = 0$) but J_2 is a copper-to-constantan junction which will add an EMF (V_2) in opposition to V_1. The resultant voltmeter reading V will be proportional to the temperature *difference* between J_1 and J_2. This says that we can't find the temperature at J_1 unless we first find the temperature of J_2.

The Reference Junction



EXTERNAL REFERENCE JUNCTION
Figure 5

One way to determine the temperature of J_2 is to physically put the junction into an ice bath, forcing its temperature to be 0°C and establishing J_2 as the *Reference Junction*. Since both voltmeter terminal junctions are now copper-copper, they create no thermal emf and the reading *V* on the voltmeter is proportional to the temperature difference between J_1 and J_2.

Now the voltmeter reading is (See Figure 5):

$$V = (V_1 - V_2) \cong \alpha\,(t_{J_1} - t_{J_2})$$

If we specify T_{J_1} in degrees Celsius:

$$T_{J_1}\,(°C) + 273.15 = t_{J_1}$$

then V becomes:

$$V = V_1 - V_2 = \alpha\left[(T_{J_1} + 273.15) - (T_{J_2} + 273.15)\right]$$

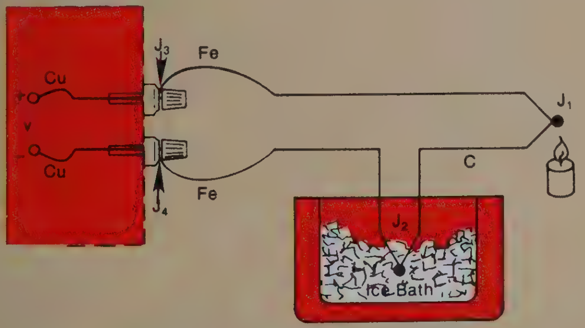
$$= \alpha\,(T_{J_1} - T_{J_2}) = \alpha(T_{J_1} - 0)$$

$$V = \alpha T_{J_1}$$

We use this protracted derivation to emphasize that the ice bath junction output, V_2, is *not* zero volts. It is a function of absolute temperature.

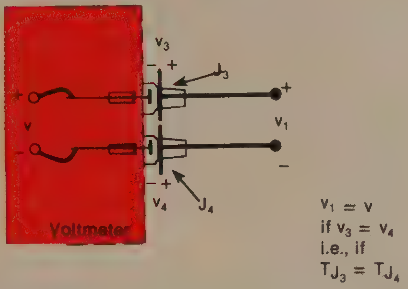
By adding the voltage of the ice point reference junction we have now referenced the reading V to 0°C. This method is very accurate because the ice point temperature can be precisely controlled. The ice point is used by the National Bureau of Standards (NBS) as the fundamental reference point for their thermocouple tables, so we can now look at the NBS tables and directly convert from voltage V to Temperature T_{J_1}.

The copper-constantan thermocouple shown in Figure 5 is a unique example because the copper wire is the same metal as the voltmeter terminals. Let's use an iron-constantan (Type J) thermocouple instead of the copper-constantan. The iron wire (Figure 6) increases the number of dissimilar metal junctions in the circuit, as both voltmeter terminals become Cu-Fe thermocouple junctions.



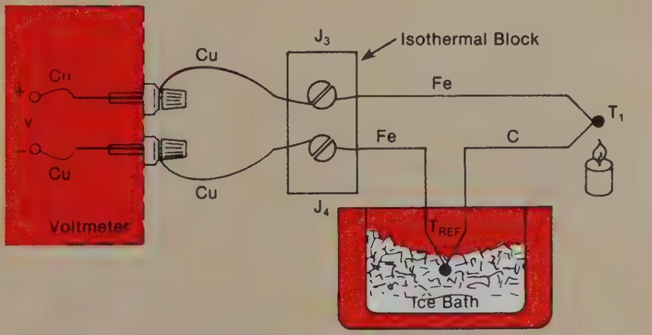
IRON-CONSTANTAN COUPLE
Figure 6

This circuit will still provide moderately accurate measurements as long as the voltmeter *high* and *low* terminals (J_3 & J_4) in opposition (Fig. 7):



JUNCTION VOLTAGE CANCELLATION
Figure 7

If both front panel terminals are not at the same temperature, there will be an error. For a more precise measurement the copper voltmeter leads should be extended so the copper-to-iron junctions are made on an *isothermal* (same temperature) block:

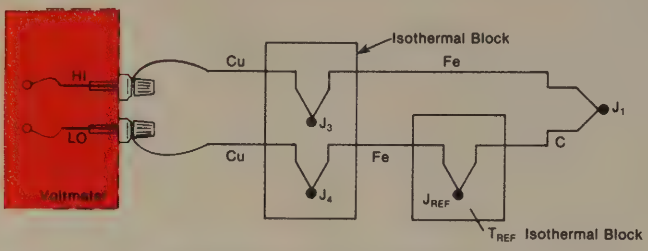


REMOVING JUNCTIONS FROM DVM TERMINALS
Figure 8

The isothermal block is an electrical insulator but a good heat conductor and it serves to hold J_3 and J_4 at the same temperature. The absolute block temperature is unimportant because the two Cu-Fe junctions act in opposition. We still have

$$V = \alpha(T_1 - T_{REF})$$

Let's replace the ice bath with another isothermal block:


Isothermal Block
Cu
Fe
HI
LO
Voltmeter
J1
J3
Cu
Fe
C
J4
JREF
TREF Isothermal Block

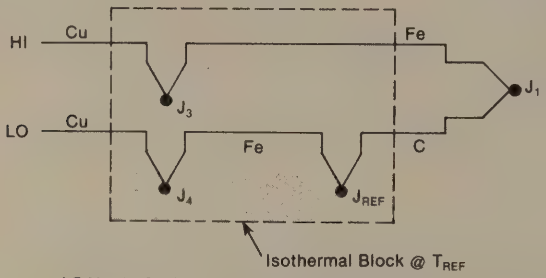
ELIMINATING THE ICE BATH
Figure 9

The new block is at Reference Temperature T_{REF}, and because J_3 and J_4 are still at the same temperature we can again show that

$$V = \alpha (T_1 - T_{REF})$$

This is still a rather inconvenient circuit because we have to connect two thermocouples. Let's eliminate the extra Fe wire in the negative (Lo) lead by combining the Cu-Fe junction (J_4) and the Fe-C junction (J_{REF}).

We can do this by first joining the two isothermal blocks (Figure 9b).

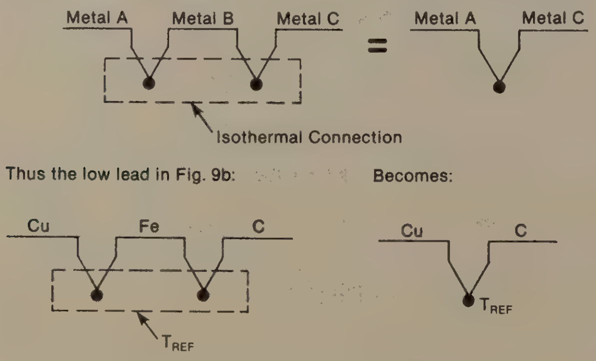

HI
Cu
Fe
J1
J3
LO
Cu
Fe
C
J4
JREF
Isothermal Block @ TREF

JOINING THE ISOTHERMAL BLOCKS
Figure 9b

We haven't changed the output voltage V. It is still

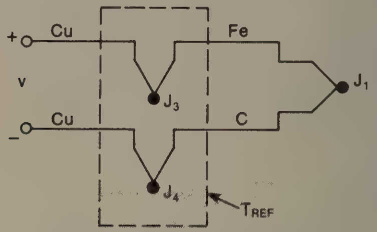
$$V = \alpha (T_{J_1} - T_{J_{REF}})$$

Now we call upon the law of intermediate metals (see Appendix A) to eliminate the extra junction. This empirical "*law*" states that a third metal (in this case, iron) inserted between the two dissimilar metals of a thermocouple junction will have no effect upon the output voltage as long as the two junctions formed by the additional metal are at the same temperature:


Metal A
Metal B
Metal C
=
Metal A
Metal C
Isothermal Connection
Thus the low lead in Fig. 9b:
Becomes:
Cu
Fe
C
TREF
Cu
C
TREF

LAW OF INTERMEDIATE METALS
Figure 10

This is a useful conclusion, as it completely eliminates the need for the iron (Fe) wire in the *LO* lead:

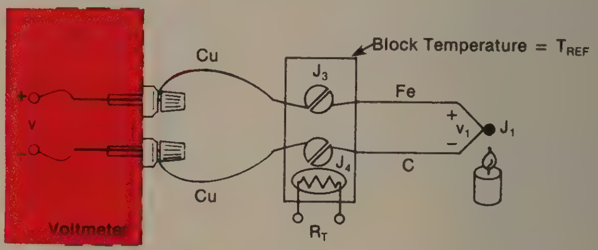

+
Cu
Fe
V
J1
J3
−
Cu
C
J4
TREF

EQUIVALENT CIRCUIT
Figure 11

Again, $V = \alpha (T_{J_1} - T_{REF})$, where α is the Seebeck coefficient for an Fe-C thermocouple.

Junctions J_3 and J_4 take the place of the ice bath. These two junctions now become the *Reference Junction* .

Now we can proceed to the next logical step: Directly measure the temperature of the isothermal block (the *Reference Junction*) and use that information to compute the unknown temperature, T_{J_1}).


Block Temperature = TREF
Cu
J3
Fe
+
V
−
+
V1
−
J1
J4
C
Cu
Voltmeter
RT

EXTERNAL REFERENCE JUNCTION-NO ICE BATH
Figure 12

A thermistor, whose resistance R_T is a function of temperature, provides us with a way to measure the absolute temperature of the reference junction. Junctions J_3 and J_4 and the thermistor are all assumed to be at the same temperature, due to the design of the isothermal block. Using a digital multimeter under computer control, we simply:

1) Measure R_T to find T_{REF} and convert T_{REF} to its equivalent reference junction voltage, V_{REF}
2) Measure V and subtract V_{REF} to find V_1, and convert V_1 to temperature T_{J_1}

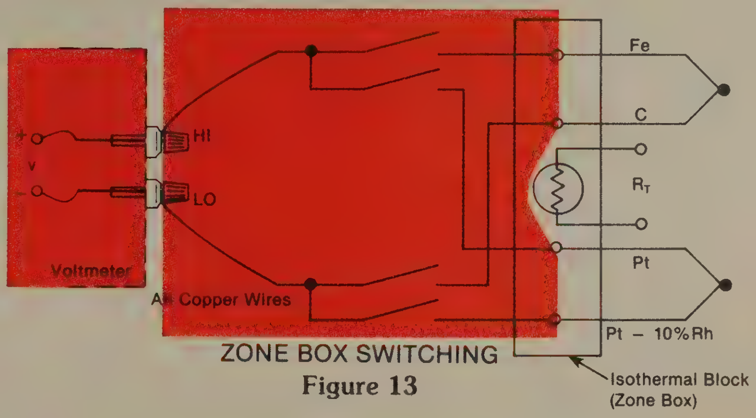
This procedure is known as *Software Compensation* because it relies upon the software of a computer to compensate for the effect of the reference junction. The isothermal terminal block temperature sensor can be any device which has a characteristic proportional to absolute temperature: an RTD, a Thermistor, or an integrated circuit sensor.

It seems logical to ask: If we already have a device that will measure absolute temperature, (like an RTD or thermistor) why do we even bother with a thermocouple that requires reference junction compensation? The single most important answer to this question is that the thermistor, the RTD, and the integrated circuit transducer are only useful over a certain temperature range. Thermocouples, on the other hand, can be used over a range of temperatures, and optimized for various atmospheres. They are much more rugged than thermistors, as evidenced by the fact that thermocouples are often welded to a metal part or clamped under a screw. They can be manufactured on the spot, either by soldering or welding. In short, thermocouples are the most versatile temperature transducer available and since the measurement system performs the entire task of reference compensation and software voltage-to-temperature conversion, using a thermocouple becomes as easy as connecting a pair of wires.

Thermocouple measurement becomes especially convenient when we are required to monitor a large number of data points. This is accomplished by using the isothermal reference junction for more than one thermocouple element (see Figure 13).

A reed relay scanner connects the voltmeter to the various thermocouples in sequence. All of the voltmeter and scanner wires are copper, independent of the type of thermocouple chosen. In fact, as long as we know what each thermocouple is, we can mix thermocouple types on the same isothermal junction block (often called a *zone box*) and make the appropriate modifications in software. The junction block temperature sensor, R_T is located at the center of the block to minimize errors due to thermal gradients.

Software compensation is the most versatile technique we have for measuring thermocouples. Many thermocouples are connected on the same block, copper leads are used throughout the scanner, and the technique is independent of the types of thermocouples chosen. In addition, when using a data acquisition system with a built-in zone box, we simply connect the thermocouple as we would a pair of test leads. All of the conversions are performed by the computer. The one disadvantage is that the computer requires a small amount of additional time to calculate the reference junction temperature. For maximum speed we can use hardware compensation.



ZONE BOX SWITCHING
Figure 13

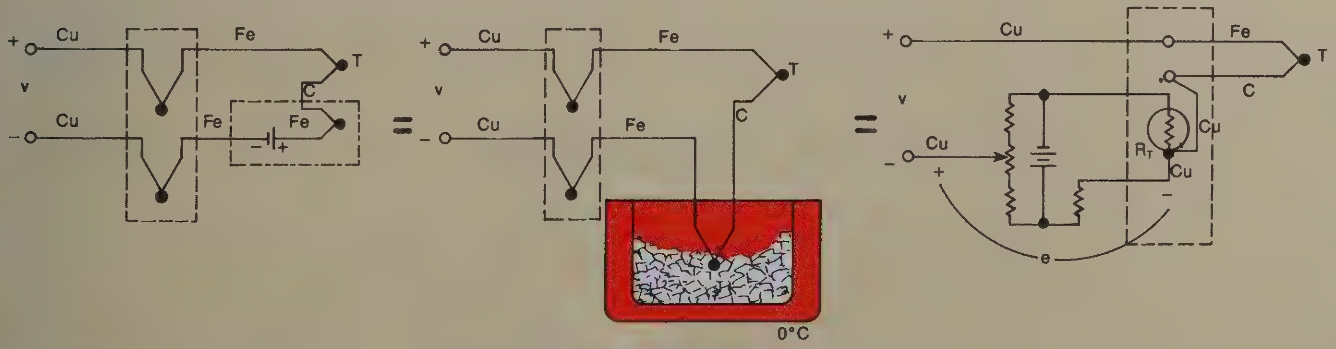
Hardware Compensation

Rather than measuring the temperature of the reference junction and computing its equivalent voltage as we did with software compensation, we could insert a battery to cancel the offset voltage of the reference junction. The combination of this *hardware compensation* voltage and the reference junction voltage is equal to that of a 0°C junction.

The compensation voltage, e, is a function of the temperature sensing resistor, R_T. The voltage V is now referenced to 0°C, and may be read directly and converted to temperature by using the NBS tables.

Another name for this circuit is the *electronic ice point reference.*[6] These circuits are commercially available for use with any voltmeter and with a wide variety of thermocouples. The major drawback is that a unique ice point reference circuit is usually needed for each individual thermocouple type.

Figure 15 shows a practical ice point reference circuit that can be used in conjunction with a reed relay scanner to compensate an entire block of thermocouple inputs. All the thermocouples in the block must be of the same type, but each block of inputs can accommodate a different thermocouple type by simply changing gain resistors.



HARDWARE COMPENSATION CIRCUIT
Figure 14

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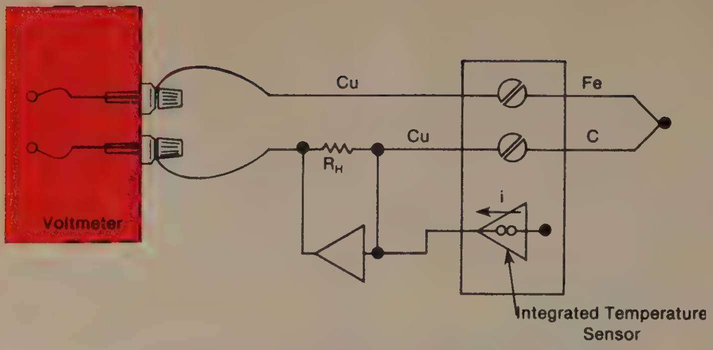
[6] Refer to Bibliography 6.

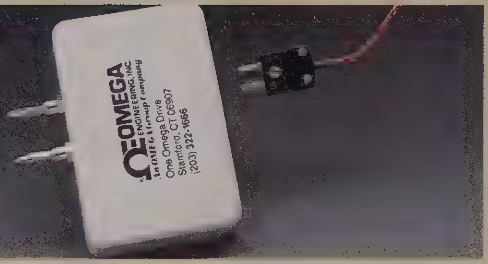


PRACTICAL HARDWARE COMPENSATION
Figure 15

The advantage of the hardware compensation circuit or *electronic ice point reference* is that we eliminate the need to compute the reference temperature. This saves us two computation steps and makes a hardware compensation temperature measurement somewhat faster than a software compensation measurement.

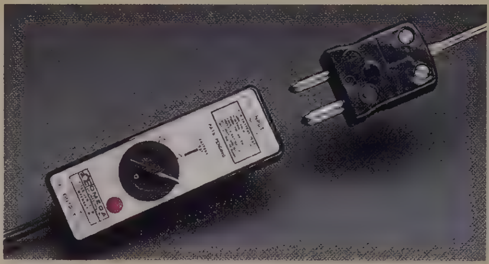
HARDWARE COMPENSATION	SOFTWARE COMPENSATION
Fast Restricted to one thermocouple type per card	Requires more computer manipulation time Versatile – accepts any thermocouple

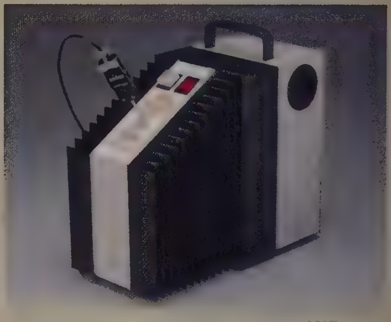
Table 2



OMEGA TAC—Electronic Ice Point and Thermocouple Preamplifier/Linearizer Plugs into Standard Connector.

OMEGA Electronic Ice Point Built into Thermocouple Connector—"MCJ"





OMEGA Ice Point Reference Chamber. Electronic Refrigeration Eliminates Ice Bath.

Voltage-To-Temperature Conversion

We have used hardware and software compensation to synthesize an ice-point reference. Now all we have to do is to read the digital voltmeter and convert the voltage reading to a temperature. Unfortunately, the temperature-versus-voltage relationship of a thermocouple is not linear. Output voltages for the more common thermocouples are plotted as a function of temperature in Figure 16. If the slope of the curve (the Seebeck coefficient) is plotted vs. temperature, as in Figure 17, it becomes quite obvious that the thermocouple is a non-linear device.

A horizontal line in Figure 17 would indicate a constant α, in other words, a linear device. We notice that the slope of the type K thermocouple approaches a constant over a temperature range from 0°C to 1000 °C. Consequently, the type K can be used with a multiplying voltmeter and an external ice point reference to obtain a moderately accurate direct readout of temperature. That is, the temperature display involves only a scale factor. This procedure works with voltmeters.*

By examining the variations in Seebeck coefficient, we can easily see that using one constant scale factor would limit the temperature range of the system and restrict the system accuracy. Better conversion accuracy can be obtained by reading the voltmeter and consulting the National Bureau of Standards Thermocouple Tables[4] in Section T of the *OMEGA TEMPERATURE MEASUREMENT HANDBOOK* – see Table 3. We could store these *look-up* table values in a computer, but they would consume an inordinate amount of memory. A more viable approach is to approximate the table values using a power series polynomial:

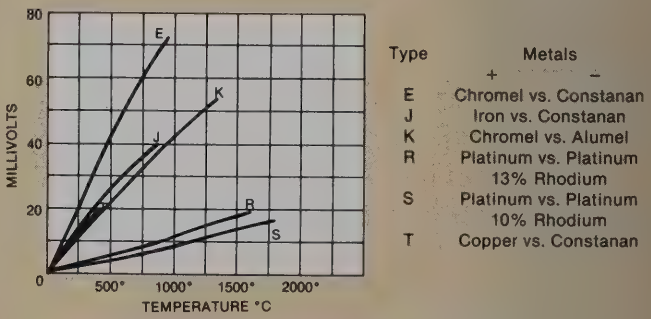
$$T = a_0 + a_1 x + a_2 x^2 + a_3 x^3 + \ldots + a_n x^n$$

where

T = Temperature
x = Thermocouple Voltage
a = Polynomial coefficients unique to each thermocouple
n = Maximum order of the polynomial

As n increases, the accuracy of the polynomial improves. A representative number is n = 9 for ±1°C accuracy. Lower order polynomials may be used over a narrow temperature range to obtain higher system speed.

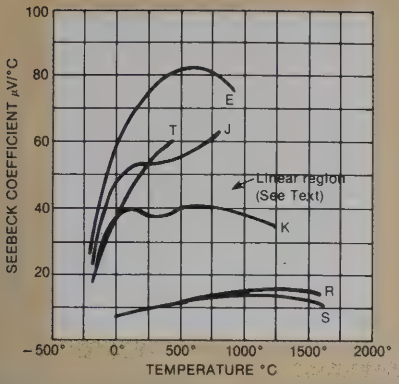
Table 4 is an example of the polynomials used in conjunction with system software compensation packages for a data acquisition system. Rather than directly calculating the exponentials, the computer is programmed to use the *nested polynomial* form to save execution time. The polynomial *fit* rapidly degrades outside the temperature range shown in Table 4 and should not be extrapolated outside those limits.



THERMOCOUPLE TEMPERATURE
vs.
VOLTAGE GRAPH
Figure 16

*Some recommended voltmeters that can be used are: *HEWLETT PACKARD* models 3455A, 3456B and 3467A.

[4] Refer to Bibliography 4.



SEEBECK COEEFICIENT vs.TEMPERATURE
Figure 17

mV	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09	.10	mV
	TEMPERATURES IN DEGREES C (IPTS 1968)											
0.00	0.00	0.17	0.34	0.51	0.68	0.85	1.02	1.19	1.36	1.53	1.70	0.00
0.10	1.70	1.87	2.04	2.21	2.38	2.55	2.72	2.89	3.06	3.23	3.40	0.10
0.20	3.40	3.57	3.74	3.91	4.08	4.25	4.42	4.58	4.75	4.92	5.09	0.20
0.30	5.09	5.26	5.43	5.60	5.77	5.94	6.11	6.27	6.44	6.61	6.78	0.30
0.40	6.78	6.95	7.12	7.29	7.46	7.62	7.79	7.96	8.13	8.30	8.47	0.40
0.50	8.47	8.63	8.80	8.97	9.14	9.31	9.47	9.64	9.81	9.98	10.15	0.50
0.60	10.15	10.31	10.48	10.65	10.82	10.98	11.15	11.32	11.49	11.65	11.82	0.60
0.70	11.82	11.99	12.16	12.32	12.49	12.66	12.83	12.99	13.16	13.33	13.49	0.70
0.80	13.49	13.66	13.83	13.99	14.16	14.33	14.49	14.66	14.83	14.99	15.16	0.80
0.90	15.16	15.33	15.49	15.66	15.83	15.99	16.16	16.33	16.49	16.66	16.83	0.90
1.00	16.83	16.99	17.16	17.32	17.49	17.66	17.82	17.99	18.15	18.32	18.48	1.00
1.10	18.48	18.65	18.82	18.98	19.15	19.31	19.48	19.64	19.81	19.97	20.14	1.10
1.20	20.14	20.31	20.47	20.64	20.80	20.97	21.13	21.30	21.46	21.63	21.79	1.20
1.30	21.79	21.96	22.12	22.29	22.45	22.62	22.78	22.94	23.11	23.27	23.44	1.30
1.40	23.44	23.60	23.77	23.93	24.10	24.26	24.42	24.59	24.75	24.92	25.08	1.40

TYPE E THERMOCOUPLE
Table 3

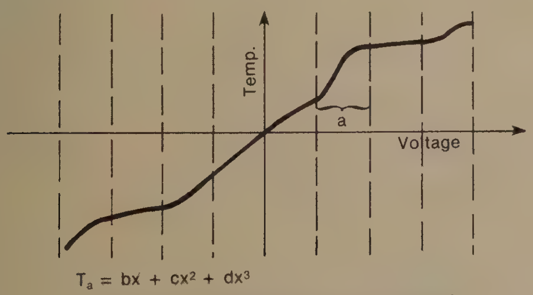
	TYPE E	TYPE J	TYPE K	TYPE R	TYPE S	TYPE T
	Nickel-10% Chromium(+) Versus Constantan(−)	**Iron(+) Versus Constantan(−)**	**Nickel-10% Chromium(+) Versus Nickel-5%(−) (Aluminum Silicon)**	**Platinum-13% Rhodium(+) Versus Platinum(−)**	**Platinum-10% Rhodium(+) Versus Platinum(−)**	**Copper(+) Versus Constantan(−)**
	−100°C to 1000°C* ±0.5°C 9th order	0°C to 760°C* ±0 1°C 5th order	0°C to 1370° C* ±0.7°C 8th order	0°C to 1000°C* ±0.5°C 8th order*	0°C to 1750°C* ±1°C 9th order	−160°C to 400°C* ±0 5°C 7th order
a_0	0.104967248	−0 048868252	0 226584602	0.263632917	0.927763167	0.100860910
a_1	17189.45282	19873.14503	24152.10900	179075.491	169526 5150	25727 94369
a_2	−282639.0850	−218614 5353	67233.4248	−48840341.37	−31568363 94	−767345.8295
a_3	12695339.5	11569199 78	2210340 682	1 90002E + 10	8990730663	78025595.81
a_4	−448703084.6	−264917531.4	−860963914.9	−4 82704E + 12	−1.63565E + 12	−9247486589
a_5	1.10866E + 10	2018441314	4.83506E + 10	7.62091E + 14	1.88027E + 14	6.97688E + 11
a_6	−1.76807E + 11		−1.18452E + 12	−7.20026E + 16	−1.37241E + 16	−2.66192E + 13
a_7	1.71842E + 12		1.38690E + 13	3.71496E + 18	6.17501E + 17	3.94078E + 14
a_8	−9.19278E + 12		−6.33708E + 13	−8.03104E + 19	−1.56105E + 19	
a_9	2.06132E + 13				1.69535E + 20	

TEMPERATURE CONVERSION EQUATION: $T = a_0 + a_1 x + a_2x^2 + \ldots + a_n x^n$

NESTED POLYNOMIAL FORM: $T = a_0 + x(a_1 + x(a_2 + x(a_3 + x(a_4 + a_5x))))$ (5th order)

NBS POLYNOMIAL COEFFICIENTS
Table 4

The calculation of high-order polynomials is a time-consuming task for a computer. As we mentioned before, we can save time by using a lower order polynomial for a smaller temperature range. In the software for one data acquisition system, the thermocouple characteristic curve is divided into eight sectors and each sector is approximated by a third-order polynomial.*



CURVE DIVIDED INTO SECTORS
Figure 18

All the foregoing procedures assume the thermocouple voltage can be measured accurately and easily; however, a quick glance at Table 3 shows us that thermocouple output voltages are very small indeed. Examine the requirements of the system voltmeter:

THERMOCOUPLE TYPE	SEEBECK COEFFICIENT (μV °C)	DVM SENSITIVITY FOR 0.1°C (μV)
E	62	6 2
J	51	5.1
K	40	4.0
R	7	0.7
S	7	0.7
T	40	4.0

REQUIRED DVM SENSITIVITY
Table 5

Even for the common type K thermocouple, the voltmeter must be able to resolve 4 μV to detect a 0.1°C change. The magnitude of this signal is an open invitation for noise to creep into any system. For this reason instrument designers utilize several fundamental noise rejection techniques, including tree switching, normal mode filtering, integration and guarding.

HEWLETT PACKARD 3054A.

PRACTICAL THERMOCOUPLE MEASUREMENT

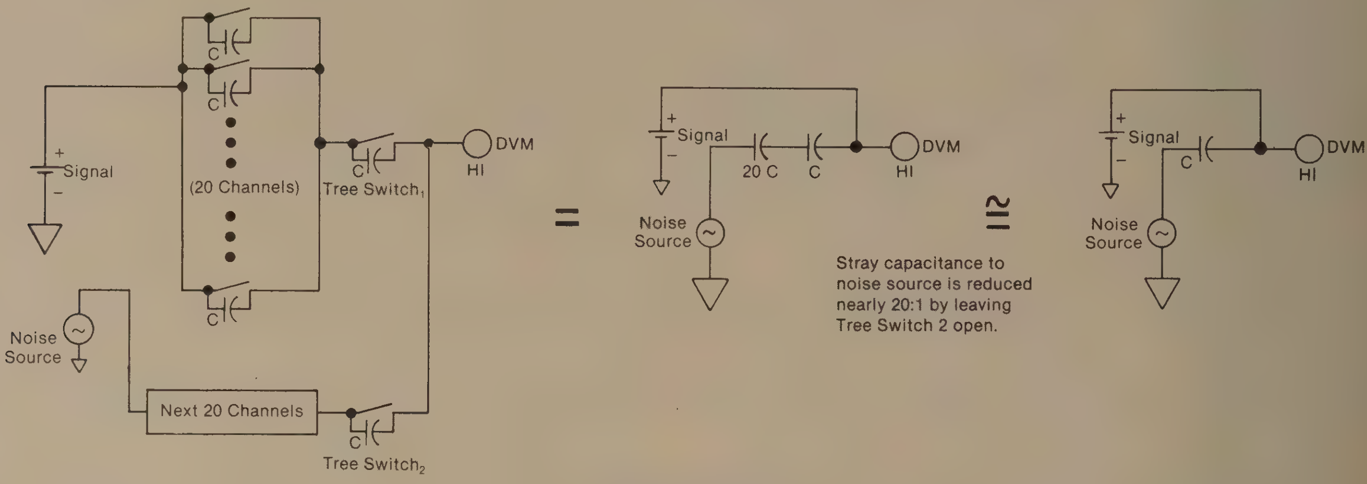
Noise Rejection

Tree Switching – Tree switching is a method of organizing the channels of a scanner into groups, each with its own main switch.

Without tree switching, every channel can contribute noise directly through its *stray* capacitance. With tree switching, groups of parallel channel capacitances are in series with a single *tree switch* capacitance. The result is greatly reduced crosstalk in a large data acquisition system, due to the reduced interchannel capacitance.

Guarding – Guarding is a technique used to reduce interference from any noise source that is common to both high and low measurement leads, i.e., from *common mode* noise sources.

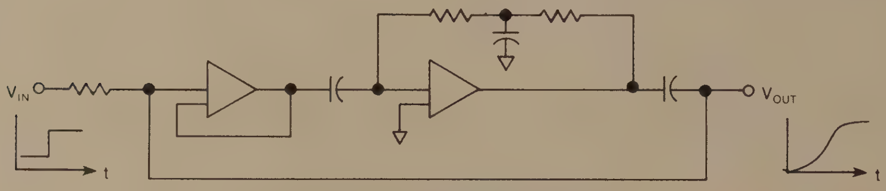
Let's assume a thermocouple wire has been pulled through the same conduit as a 220V AC supply line. The capacitance between the power lines and the thermocouple lines will create an AC signal of approximately equal magnitude on both thermocouple wires. This *common mode* signal is not a problem in an ideal circuit, but the voltmeter is not ideal. It has some capacitance between its low terminal and safety ground (chassis). Current flows through this capacitance and through the thermocouple lead resistance, creating a normal mode noise signal. The guard, physically a floating metal box surrounding the entire voltmeter circuit, is connected to a shield surrounding the thermocouple wire, and serves to shunt the interfering current.



Stray capacitance to noise source is reduced nearly 20:1 by leaving Tree Switch 2 open.

TREE SWITCHING
Figure 19

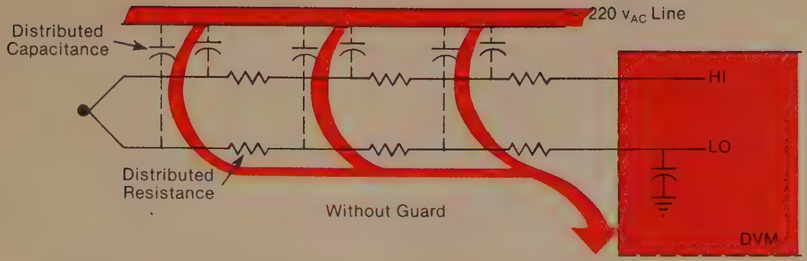
Analog Filter – A filter may be used directly at the input of a voltmeter to reduce noise. It reduces interference dramatically, but causes the voltmeter to respond more slowly to step inputs.



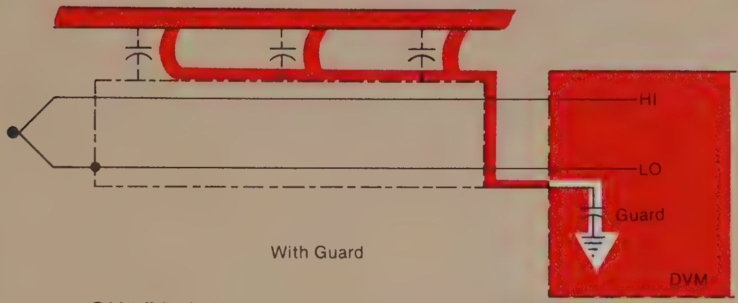
ANALOG FILTER (3456A)
Figure 20

Integration – Integration is an A/D technique which essentially averages noise over a full line cycle, thus power line-related noise and its harmonics are virtually eliminated. If the integration period is chosen to be less than an integer line cycle, its noise rejection properties are essentially negated.

Since thermocouple circuits that cover long distances are especially susceptible to power line related noise, it is advisable to use an integrating analog to digital conveter to measure the thermocouple voltage. Integration is an especially attractive A/D technique in light of recent innovations which allow reading rates of 48 samples per second with full cycle integration.



Without Guard



With Guard

GUARD SHUNTS INTERFERING CURRENT
Figure 21

Each shielded thermocouple junction can directly contact an interfering source with no adverse effects, since provision is made on the scanner to switch the guard terminal separately for each thermocouple channel. This method of connecting the shield to guard serves to eliminate *ground loops* often created when the shields are connected to earth ground.

The dvm guard is especially useful in eliminating noise voltages created when the thermocouple junction comes into direct contact with a common mode noise source.

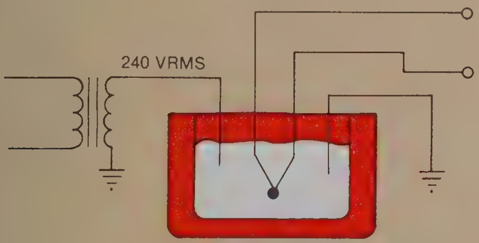


Figure 22

In Figure 22 we want to measure the temperature at the center of a molten metal bath that is being heated by electric current. The potential at the center of the bath is 120V RMS. The equivalent circuit is:

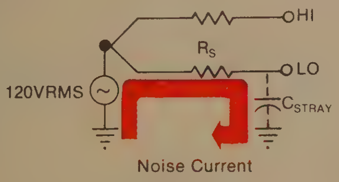


Figure 23

The stray capacitance from the dvm Lo terminal to chassis causes a current to flow in the low lead, which in turn causes a noise voltage to be dropped across the series resistance of the thermocouple, R_s. This voltage appears directly across the dvm Hi to Lo terminals and causes a noisy measurement. If we use a guard lead connected directly to the thermocouple, we drastically reduce the current flowing in the Lo lead. The noise current now flows in the guard lead where it cannot affect the reading:

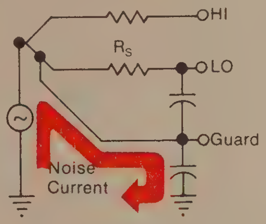


Figure 24

Notice that we can also minimize the noise by minimizing R_S. We do this by using larger thermocouple wire that has a smaller series resistance.

To reduce the possibility of magnetically induced noise, the thermocouple should be twisted in a uniform manner. Thermocouple *extension wires* are available commercially in a *twisted pair* configuration.

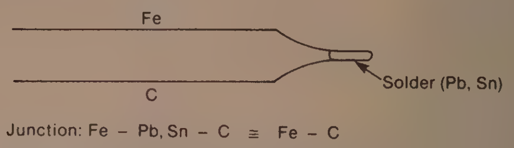
Practical Precautions – We have discussed the concepts of the reference junction, how to use a polynomial to extract absolute temperature data, and what to look for in a data acquisition system, to minimize the effects of noise. Now let's look at the thermocouple wire itself. The polynomial curve fit relies upon the thermocouple wire being perfect; that is, it must not become *decalibrated* during the act of making a temperature measurement. We shall now discuss some of the pitfalls of thermocouple thermometry.

Aside from the specified accuracies of the data acquisition system and its zone box, most measurement errors may be traced to one of these primary sources:

1. Poor junction connection
2. Decalibration of thermocouple wire
3. Shunt impedance and galvanic action
4. Thermal shunting
5. Noise and leakage currents
6. Thermocouple specifications
7. Documentation

Poor Junction Connection

There are a number of acceptable ways to connect two thermocouple wires: soldering, silver-soldering, welding, etc. When the thermocouple wires are soldered together, we introduce a third metal into the thermocouple circuit, but as long as the temperatures on both sides of the thermocouple are the same, the solder should not introduce an error. The solder does limit the maximum temperature to which we can subject this junction. To reach a higher measurement temperature, the joint must be welded. But welding is not a process to be taken lightly[5]. Overheating can degrade the wire, and the welding gas and the atmosphere in which the wire is welded can both diffuse into the thermocouple metal, changing its characteristics. The difficulty is compounded by the very different nature of the two metals being joined. Commercial thermocouples are welded on expensive machinery using a capacitive-discharge technique to insure uniformity.



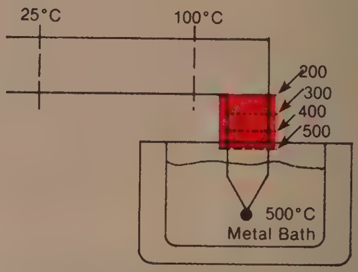
SOLDERING A THERMOCOUPLE
Figure 25

A poor weld can, of course, result in an open connection, which can be detected in a measurement situation by performing an *open thermocouple check*. This is a common test function available with data loggers. While the open thermocouple is the easiest malfunction to detect, it is not necessarily the most common mode of failure.

Decalibration

Decalibration is a far more serious fault condition than the open thermocouple because it can result in a temperature reading that *appears* to be correct. *Decalibration* describes the process of unintentionally altering the physical makeup of the thermocouple wire so that it no longer conforms to the NBS polynomial within specified limits. Decalibration can result from diffusion of atmospheric particles into the metal, caused by temperature extremes. It can be caused by high temperature annealing or by *cold-working* the metal, an effect that can occur when the wire is drawn through a conduit or strained by rough handling or vibration. Annealing can occur within the section of wire that undergoes a temperature gradient.

Robert Moffat in his *Gradient Approach to Thermocouple Thermometry* explains that the thermocouple voltage is actually generated by the section of wire that contains the temperature gradient, and not necessarily by the junction.[9] For example, if we have a thermal probe located in a molten metal bath, there will be two regions that are virtually isothermal and one that has a large gradient:



GRADIENT PRODUCES VOLTAGE
Figure 26

In Figure 26, the thermocouple junction will not produce *any* part of the output voltage. The shaded section will be the one producing virtually the entire thermocouple output voltage. If, due to aging or annealing, the output of this thermocouple were found to be drifting, replacing only the thermocouple junction would not solve the problem. We would have to replace the entire shaded section, since it is the source of the thermocouple voltage.

Thermocouple wire obviously can't be manufactured perfectly; there will be some defects which will cause output voltage errors. These *inhomogeneities* can be especially disruptive if they occur in a region of steep temperature gradient. Since we don't know where an imperfection will occur within a wire, the best thing we can do is to avoid creating a steep gradient. Gradients can be reduced by using metallic sleeving or by careful placement of the thermocouple wire.

Shunt Impedance

High temperatures can also take their toll on thermocouple wire *insulators*. Insulation resistance decreases exponentially with increasing temperature, even to the point that it creates a *virtual junction*[7]. Assume we have a completely open thermocouple operating at a high temperature.

The leakage Resistance, R_L, can be sufficiently low to complete the circuit path and give us an improper voltage reading. Now let's assume the thermocouple is not open, but we are using a very long section of small diameter wire.

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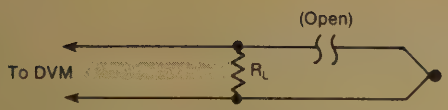
[5] Refer to Bibliography 5.

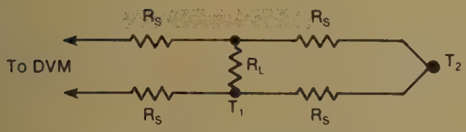
[9] Refer to Bibliography 9.

[7] Refer to Bibliography 7.



LEAKAGE RESISTANCE

Figure 27



VIRTUAL JUNCTION

Figure 28

If the thermocouple wire is small, its series resistance, R_S, will be quite high and under extreme conditions $R_L << R_S$. This means that the thermocouple *junction* will appear to be at R_L and the output will be proportional to T_1, not T_2.

High temperatures have other detrimental effects on thermocouple wire. The impurities and chemicals within the insulation can actually diffuse into the thermocouple metal causing the temperature-voltage dependence to deviate from the published values. When using thermocouples at high temperatures, the insulation should be chosen carefully. Atmospheric effects can be minimized by choosing the proper protective metallic or ceramic sheath.

Galvanic Action

The dyes used in some thermocouple insulation will form an electrolyte in the presence of water. This creates a galvanic action, with a resultant output hundreds of times greater than the Seebeck effect. Precautions should be taken to shield the thermocouple wires from all harsh atmospheres and liquids.

Thermal Shunting

No thermocouple can be made without mass. Since it takes energy to heat any mass, the thermocouple will slightly alter the temperature it was meant to measure. If the mass to be measured is small, the thermocouple must naturally be small. But a thermocouple made with small wire is far more susceptible to the problems of contamination, annealing, strain, and shunt impedance. To minimize these effects, thermocouple *extension wire* can be used. Extension wire is commercially available wire primarily intended to cover long distances between the measuring thermocouple and the voltmeter.

Extension wire is made of metals having Seebeck coefficients very similar to a particular thermocouple type. It is generally larger in size so that its series resistance does not become a factor when traversing long distances. It can also be pulled more readily through conduit than very small thermocouple wire. It generally is specified over a much lower temperature range than premium-grade thermocouple wire. In addition to offering a practical size advantage, extension wire is less expensive than standard thermocouple wire. This is especially true in the case of platinum-based thermocouples.

Since the extension wire is specified over a narrower temperature range and it is more likely to receive mechanical stress, the temperature gradient across the extension wire should be kept to a minimum. This, according to the gradient theory, assures that virtually none of the output signal will be affected by the extension wire.

Noise – We have already discussed line-related noise as it pertains to the data acquisition system. The techniques of integration, tree switching and guarding serve to cancel most line-related interference. Broadband noise can be rejected with the analog filter.

The one type of *noise* the data acquisition system cannot reject is a dc offset caused by a dc leakage current in the system. While it is less common to see dc leakage currents of sufficient magnitude to cause appreciable error, the possibility of their presence should be noted and prevented, especially if the thermocouple wire is very small and the related series impedance is high.

Wire Calibration

Thermocouple wire is manufactured to a certain specification, signifying its conformance with the NBS tables. The specification can sometimes be enhanced by *calibrating* the wire (testing it at known temperatures). Consecutive pieces of wire on a continuous spool will generally track each other more closely than the specified tolerance, although their output voltages may be slightly removed from the center of the absolute specification.

If the wire is calibrated in an effort to improve its fundamental specifications, it becomes even more imperative that all of the aforementioned conditions be heeded in order to avoid decalibration.

Documentation – It may seem incongruous to speak of documentation as being a source of voltage measurement error, but the fact is that thermocouple systems, by their very ease of use, invite a large number of data points. The sheer magnitude of the data can become quite unwieldy. When a large amount of data is taken, there is an increased probability of error due to mislabeling of lines, using the wrong NBS curve, etc.

Since channel numbers invariably change, data should be categorized by measurand, not just channel number.[10] Information about any given measurand, such as transducer type, output voltage, typical value, and location can be maintained in a data file. This can be done under computer control or simply by filling out a pre-printed form. No matter how the data is maintained, the importance of a concise system should not be underestimated, especially at the outset of a complex data gathering project.

Diagnostics

Most of the sources of error that we have mentioned are aggravated by using the thermocouple near its temperature limits. These conditions will be encountered infrequently in most applications. But what about the situation where we are using small thermocouples in a harsh atmosphere at high temperatures? How can we tell when the thermocouple is producing erroneous results? We need to develop a reliable set of diagnostic procedures.

Through the use of diagnostic techniques, R.P. Reed has developed an excellent system for detecting a faulty thermocouple and data channels.[10] Three components of this system are the event record, the zone box test, and the thermocouple resistance history.

Event Record – The first diagnostic is not a test at all, but a recording of all pertinent events that could even remotely affect the measurements. An example would be:

MARCH 18 EVENT RECORD

10:43	Power failure
10:47	System power returned
11:05	Changed M821 to type K thermocouple
13:51	New data acquisition program
16:07	M821 appears to be bad reading

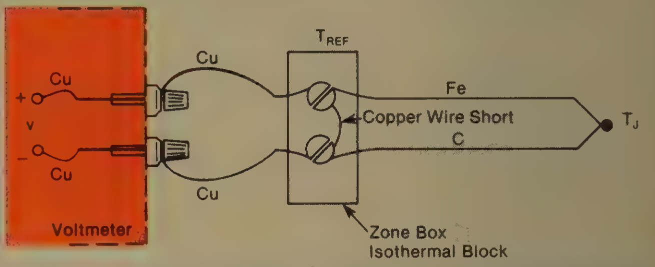
Figure 29

We look at our program listing and find that measurand #M821 uses a type J thermocouple and that our new data acquisition program interprets it as a type J. But from the event record, apparently thermocouple M821 was changed to a type K, and the change was not entered into the program. While most anomalies are not discovered this easily, the event record can provide valuable insight into the reason for an unexplained change in a system measurement. This is especially true in a system configured to measure hundreds of data points.

Zone Box Test – The zone box is the isothermal terminal block of known temperature used in place of an ice bath reference. If we temporarily short-circuit the thermocouple directly at the zone box, the system should read a temperature very close to that of the zone box, i.e., close to room temperature.

If the thermocouple lead resistance is much greater than the shunting resistance, the copper wire shunt forces V = 0. In the normal *unshorted* case, we want to measure T_J, and the system reads:

$$V \cong \alpha(T_J - T_{REF})$$



SHORTING THE THERMOCOUPLE AT THE TERMINALS

Figure 30

But, for the functional test, we have shorted the terminals so that V = 0. The indicated temperature T'_J is thus:

$$0 = \alpha(T'_J - T_{REF})$$

$$T'_J = T_{REF}$$

Thus, for a dvm reading of V = 0, the system will indicate the zone box temperature. First we observe the temperature T_J (forced to be different from T_{REF}), then we short the thermocouple with a copper wire and make sure that the system indicates the zone box temperature instead of T_J.

This simple test verifies that the controller, scanner, voltmeter and zone box compensation are all operating correctly. In fact, this simple procedure tests everything but the thermocouple wire itself.

Thermocouple Resistance – A sudden change in the resistance of a thermocouple circuit can act as a warning indicator. If we plot resistance vs. time for each set of thermocouple wires, we can immediately spot a sudden resistance change, which could be an indication of an open wire, a wire shorted due to insulation failure, changes due to vibration fatigue, or one of many failure mechanisms.

For example, assume we have the thermocouple measurement shown in Figure 31.

We want to measure the temperature profile of an underground seam of coal that has been ignited. The wire passes through a high temperature region, into a cooler region. Suddenly, the temperature we measure rises from 300°C to 1200°C. Has the burning section of the coal seam migrated to a different location, or has

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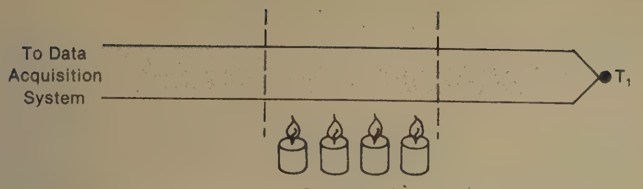
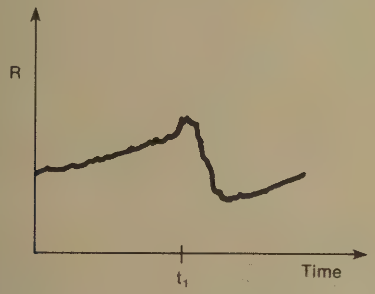
[10] Refer to Bibliography 10.



BURNING COAL SEAM
Figure 31

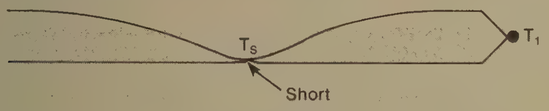
the thermocouple insulation failed, thus causing a short circuit between the two wires at the point of a hot spot?

If we have a continuous history of the thermocouple wire resistance, we can reduce what has actually happened.



THERMOCOUPLE RESISTANCE vs. TIME
Figure 32

The resistance of the thermocouple will naturally change with time as the resistivity of the wire changes due to varying temperature. But a sudden change in resistance is an indication that something is wrong. In this case, the resistance has dropped abruptly, indicating that the insulation has failed, effectively shortening the thermocouple loop.



CAUSE OF THE RESISTANCE CHANGE
Figure 33

The new junction will measure temperature T_S, not T_1. The resistance measurement has given us additional information to help interpret the physical phenomenon that has occurred. This failure would not have been detected by a standard *open thermocouple* check.

Measuring Resistance – We have casually mentioned checking the resistance of the thermocouple wire, as if it were a straightforward measurement. But keep in mind that when the thermocouple is producing a voltage, this voltage can cause a large resistance measurement error. Measuring the resistance of a thermocouple is akin to measuring the internal resistance of a battery. We can attack this problem with a technique known as *offset compensated ohms measurement*.

As the name implies, the voltmeter first measures the thermocouple offset voltage without the ohms current source applied. Then the ohms current source is switched on and the voltage across the resistance is again measured. The voltmeter software compensates for the offset voltage of the thermocouple and calculates the actual thermocouple source resistance.

Special Thermocouples – Under extreme conditions, we can even use diagnostic thermocouple circuit configurations. *Tip-branched* and *leg-branched* thermocouples are four-wire thermocouple circuits that allow redundant measurement of temperature, noise voltage and resistance for checking wire integrity. Their respective merits are discussed in detail in REF. 8.

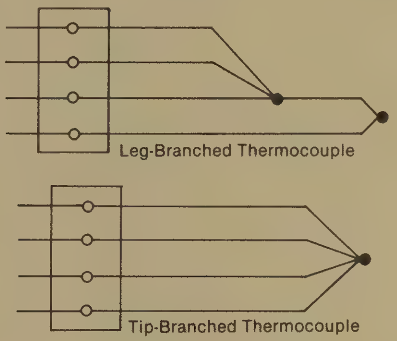


Figure 34

Only severe thermocouple applications require such extensive diagnostics, but it is comforting to know that there are procedures that can be used to verify the integrity of an important thermocouple measurement.

Summary

In summary, the integrity of a thermocouple system may be improved by following these precautions:

- Use the largest wire possible that will not shunt heat away from the measurement area.
- If small wire is required, use it only in the region of the measurement and use extension wire for the region with no temperature gradient.
- Avoid mechanical stress and vibration which could strain the wires.
- When using long thermocouple wires, connect the wire shield to the dvm guard terminal and use twisted pair extension wire.
- Avoid steep temperature gradients.
- Try to use the thermocouple wire well within its temperature rating.
- Use a guarded integrating A/D converter.
- Use the proper sheathing material in hostile environments to protect the thermocouple wire.
- Use extension wire only at low temperatures and only in regions of small gradients.
- Keep an event log and a continuous record of thermocouple resistance.

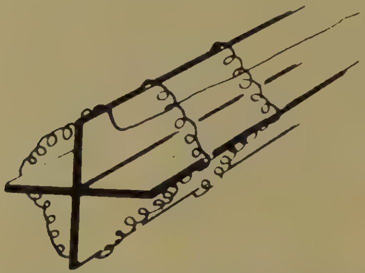
THE RTD

History

The same year that Seebeck made his discovery about thermoelectricity, Sir Humphrey Davy announced that the resistivity of metals showed a marked temperature dependence. Fifty years later, Sir William Siemens proffered the use of platinum as the element in a resistance thermometer. His choice proved most propitious, as platinum is used to this day as the primary element in all high-accuracy resistance thermometers. In fact, the Platinum Resistance Temperature Detector, or PRTD, is used today as an interpolation standard from the oxygen point (−182.96°C) to the antimony point (630.74°C).

Platinum is especially suited to this purpose, as it can withstand high temperatures while maintaining excellent stability. As a noble metal, it shows limited susceptibility to contamination.

The classical resistance temperature detector (RTD) construction using platinum was proposed by C.H. Meyers in 1932.[12] He wound a helical coil of platinum on a crossed mica web and mounted the assembly inside a glass tube. This construction minimized strain on the wire while maximizing resistance.



MEYERS RTD CONSTRUCTION
Figure 35

Although this construction produces a very stable element, the thermal contact between the platinum and the measured point is quite poor. This results in a slow thermal response time. The fragility of the structure limits its use today primarily to that of a laboratory standard.

Another laboratory standard has taken the place of the Meyer's design. This is the *bird-cage* element proposed by Evans and Burns.[16] The platinum element remains largely unsupported, which allows it to move freely when expanded or contracted by temperature variations. Strain-induced resistance changes with time and temperature are thus minimized, and the bird-cage becomes the ultimate laboratory standard. Due to the unsupported structure and subsequent susceptibility to vibration, this configuration is still a bit too fragile for industrial environments.

A more rugged construction technique is shown in Figure 37. The platinum wire is bifilar wound on a glass or ceramic bobbin. The bifilar winding reduces the effective enclosed area of the coil to minimize magnetic pickup and its related noise. Once the wire is wound onto the bobbin, the assembly is then sealed with a coating of molten glass. The sealing process assures that the RTD will maintain its integrity under extreme vibration, but it also limits the expansion of the platinum metal at high temperatures. Unless the coefficients of expansion of the platinum and the bobbin match perfectly, stress will be placed on the wire as the temperature changes, resulting in a strain-induced resistance change. This may result in a permanent change in the resistance of the wire.

There are partially supported versions of the RTD which offer a compromise between the bird-cage approach and the sealed helix. One such approach uses a platinum helix threaded through a ceramic cylinder and affixed via glass-frit. These devices will maintain excellent stability in moderately rugged vibrational applications.

Glass Sealed Bifilar Winding

Thick Film Omega Film Element

Thin Film Omega TFD Element

Typical RTD Probes

TYPICAL RTDs
Figures 36 and 37

Metal Film RTD's

In the newest construction technique, a platinum or metal-glass slurry film is deposited or screened onto a small flat ceramic substrate, etched with a laser-trimming system, and sealed. The film RTD offers substantial reduction in assembly time and has the further advantage of increased resistance for a given size. Due to the manufacturing technology, the device size itself is small, which means it can respond quickly to step changes in temperature. Film RTD's are presently less stable than their hand-made counterparts, but they are becoming more popular because of their decided advantages in size and production cost. These advantages should provide the impetus for future research needed to improve stability.

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[12] Refer to Bibliography 12.

[16] Refer to Bibliography 16.

Metals – All metals produce a positive change in resistance for a positive change in temperature. This, of course, is the main function of an RTD. As we shall soon see, system error is minimized when the nominal value of the RTD resistance is large. This implies a metal wire with a high resistivity. The lower the resistivity of the metal, the more material we will have to use.

Table 6 lists the resistivities of common RTD materials.

Because of their lower resistivities, gold and silver are rarely used as RTD elements. Tungsten has a relatively high resistivity, but is reserved for very high temperature applications because it is extremely brittle and difficult to work.

METAL		RESISTIVITY OHM/CMF (cmf = circular mil foot)
Gold	Au	13.00
Silver	Ag	8.8
Copper	Cu	9.26
Platinum	Pt	59.00
Tungsten	W	30.00
Nickel	Ni	36.00

Table 6

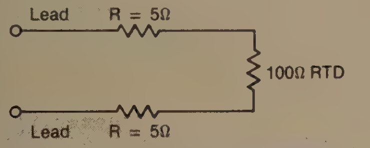
Copper is used occasionally as an RTD element. Its low resistivity forces the element to be longer than a platinum element, but its linearity and very low cost make it an economical alternative. Its upper temperature limit is only about 120°C.

The most common RTD's are made of either platinum, nickel, or nickel alloys. The economical nickel derivative wires are used over a limited temperature range. They are quite non-linear and tend to drift with time. For measurement integrity, platinum is the obvious choice.

Resistance Measurement

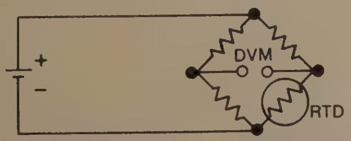
The common values of resistance for a platinum RTD range from 10 ohms for the bird-cage model to several thousand ohms for the film RTD. The single most common value is 100 ohms at 0°C. The DIN 43760 standard temperature coefficient of platinum wire is $\alpha = .00385$. For a 100 ohm wire this corresponds to +0.385 ohms/°C at 0°C. This value for α is actually the average slope from 0°C to 100°C. The more chemically pure platinum wire used in platinum resistance standards has an α of +.00392 ohms/ohm/°C.

Both the slope and the absolute value are small numbers, especially when we consider the fact that the measurement wires leading to the sensor may be several ohms or even tens of ohms. A small lead impedance can contribute a significant error to our temperature measurement.



EFFECT OF LEAD RESISTANCE
Figure 38

A ten ohm lead impedance implies $10/.385 \cong$ 26°C error in our measurement. Even the temperature coefficient of the lead wire can contribute a measurable error. The classical method of avoiding this problem has been the use of a bridge.



WHEATSTONE BRIDGE
Figure 39

The bridge output voltage is an indirect indication of the RTD resistance. The bridge requires four connection wires, an external source, and three resistors that have a zero temperature coefficient. To avoid subjecting the three bridge-completion resistors to the same temperature as the RTD, the RTD is separated from the bridge by a pair of extension wires:

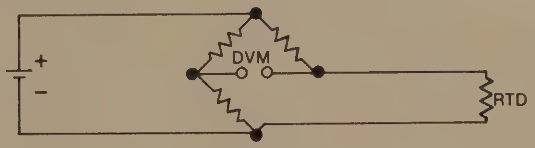
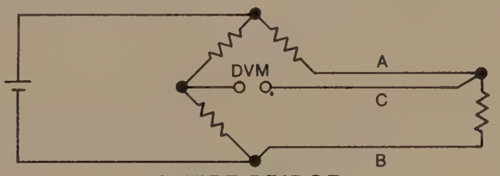


Figure 40

These extension wires recreate the problem that we had initially: The impedance of the extension wires affects the temperature reading. This effect can be minimized by using a *three-wire bridge* configuration:

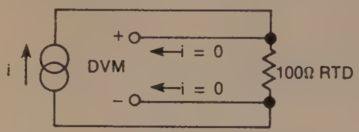


3-WIRE BRIDGE
Figure 41

If wires A and B are perfectly matched in length, their impedance effects will cancel because each is in an opposite leg of the bridge. The third wire, C, acts as a sense lead and carries no current.

The Wheatstone bridge shown in Figure 41 creates a non-linear relationship between resistance change and bridge output voltage change. This compounds the already non-linear temperature-resistance characteristic of the RTD by requiring an additional equation to convert bridge output voltage to equivalent RTD impedance.

4-Wire Ohms – The technique of using a current source along with a remotely sensed digital voltmeter alleviates many problems associated with the bridge.



4-WIRE OHMS MEASUREMENT
Figure 42

The output voltage read by the dvm is directly proportional to RTD resistance, so only one conversion equation is necessary. The three bridge-completion resistors are replaced by one reference resistor. The digital voltmeter measures only the voltage dropped across the RTD and is insensitive to the length of the lead wires.

The one disadvantage of using 4-wire ohms is that we need one more extension wire than the 3-wire bridge. This is a small price to pay if we are at all concerned with the accuracy of the temperature measurement.

3-Wire Bridge Measurement Errors

The integrity of a 3-wire bridge measurement can be maintained only if the bridge is balanced. Let's examine the balanced bridge circuit and then unbalance it to see what the effects are:

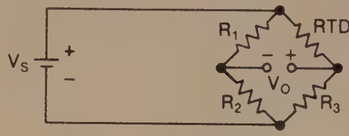


Figure 43

If we know V_S and V_O, we can find R_g and then solve for temperature. The unbalance voltage V_O of a bridge built with $R_1 = R_2$ is:

$$V_O = V_S\left(\frac{R_3}{R_3 + R_g}\right) - V_S\left(\frac{1}{2}\right)$$

If $R_g = R_3$, $V_O = 0$ and the bridge is balanced. This can be done manually, but if we don't want to do a manual bridge balance we can just solve for R_g in terms of V_O:

$$R_g = R_3\left(\frac{V_S - 2V_O}{V_S + 2V_O}\right)$$

This expression assumes the lead resistance is zero. If R_g is located some distance from the bridge in a 3-wire configuration, the lead resistance R_L will appear in series with both R_g and R_3:

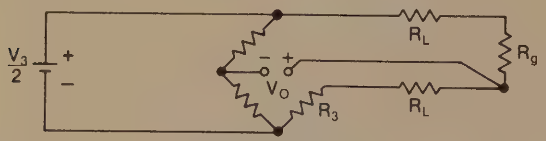


Figure 44

Again we solve for R_g:

$$R_g = R_3\left(\frac{V_S - 2V_O}{V_S + 2V_O}\right) - R_L\left(\frac{4V_O}{V_S + 2V_O}\right)$$

The error term will be small if V_O is small, i.e., the bridge is close to balance. This circuit works well with devices like strain gauges, which change resistance value by only a few percent, but an RTD changes resistance dramatically with temperature. Assume the RTD resistance is 200 ohms and the bridge is designed for 100 ohms:

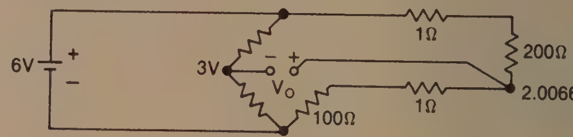


Figure 45

Since we don't know the value of R_L, we must use equation (a), so we get:

$$R_g = 100\left(\frac{6 + 1.9868}{6 - 1.9868}\right) = 199.01 \text{ ohms}$$

The correct answer is of course 200 ohms. That's a temperature error of about 2½°C.

Unless you can actually measure the resistance of R_L or balance the bridge, the basic 3-wire technique is not an accurate method for measuring absolute temperature with an RTD. A better approach is to use a 4-wire technique.

Resistance to Temperature Conversion

The RTD is a more linear device than the thermocouple, but it still requires curve-fitting. The Callendar-Van Dusen equation has been used for years to approximate the RTD curve:[11, 13]

$$R_T = R_0 + R_0\,\alpha\left[T - \delta\left(\frac{T}{100} - 1\right)\left(\frac{T}{100}\right) - \beta\left(\frac{T}{100} - 1\right)\left(\frac{T^3}{100}\right)\right]$$

Where:

R_T = Resistance at Temperature T
R_O = Resistance at T = 0°C
α = Temperature coefficient at T = 0°C (typically +0.00392Ω/Ω/°C)
δ = 1.49 (typical value for .00392 platinum)
β = 0 $\quad T > 0$
0.11 (typical) $T < 0$

The exact values for coefficients α, β, and δ are determined by testing the RTD at four temperatures and solving the resultant equations. This familiar equation was replaced in 1968 by a 20th order polynomial

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[11, 13] Refer to Bibliography 11 and 13.

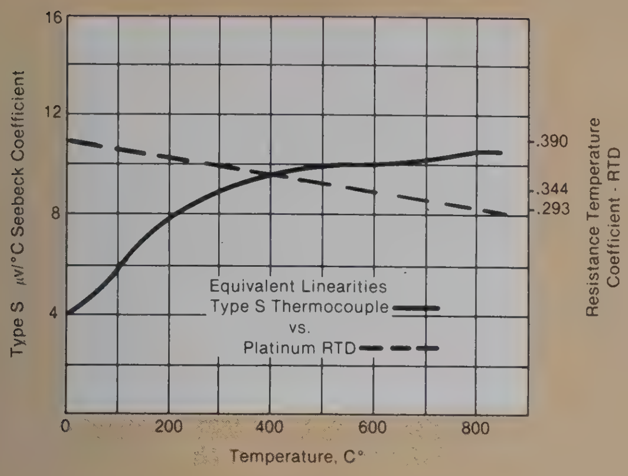

Figure 46

in order to provide a more accurate curve fit.

The plot of this equation shows the RTD to be a more linear device than the thermocouple:

Practical Precautions

The same practical precautions that apply to thermocouples also apply to RTD's, i.e., use shields and twisted-pair wire, use proper sheathing, avoid stress and steep gradients, use large extension wire, keep good documentation and use a guarded integrating dvm. In addition, the following precautions should be observed.

Construction – Due to its construction, the RTD is somewhat more fragile than the thermocouple and precautions must be taken to protect it.

Self-Heating – Unlike the thermocouple, the RTD is not self-powered. A current must be passed through the device to provide a voltage that can be measured. The current causes Joule (I^2R) heating within the RTD, changing its temperature. This *self-heating* appears as a measurement error. Consequently, attention must be paid to the magnitude of the measurement current supplied by the ohmmeter. A typical value for self-heating error is 1/2°C per milliwatt in free air. Obviously, an RTD immersed in a thermally conductive medium will distribute its Joule heat to the medium and the error due to self-heating will be smaller. The same RTD that rises 1°C per milliwatt in free air will rise only 1/10°C per milliwatt in air which is flowing at the rate of one meter per second.[6]

To reduce self-heating errors, use the minimum ohms measurement current that will still give the resolution you require, and use the largest RTD you can that will still give good response time. Obviously, there are compromises to be considered.

Thermal Shunting – Thermal shunting is the act of altering the measurement temperature by inserting a measurement transducer. Thermal shunting is more a problem with RTD's than with thermocouples, as the physical bulk of an RTD is greater than that of a thermocouple.

Small RTD	Large RTD
Fast Response Time	Slow Response Time
Low Thermal Shunting	Poor Thermal Shunting
High Self-heating Error	Low Self-heating Error

Thermal EMF – The platinum-to-copper connection that is made when the RTD is measured can cause a thermal offset voltage. The offset-compensated ohms technique can be used to eliminate this effect.

THE THERMISTOR

Like the RTD, the thermistor is also a temperature sensitive resistor. While the thermocouple is the most versatile temperature transducer and the PRTD is the most stable, the word that best describes the thermistor is *sensitive*. Of the three major categories of sensors, the thermistor exhibits by far the largest parameter change with temperature.

Thermistors are generally composed of semiconductor materials. Although positive temperature coefficient units are available, most thermistors have a negative temperature coefficient (TC); that is, their resistance decreases with increasing temperature. The negative T.C. can be as large as several percent per degree Celsius, allowing the thermistor circuit to detect minute changes in temperature which could not be observed with an RTD or thermocouple circuit.

The price we pay for this increased sensitivity is loss of linearity. The thermistor is an extremely non-linear device which is highly dependent upon process parameters. Consequently, manufacturers have not standardized thermistor curves to the extent that RTD and thermocouple curves have been standardized.

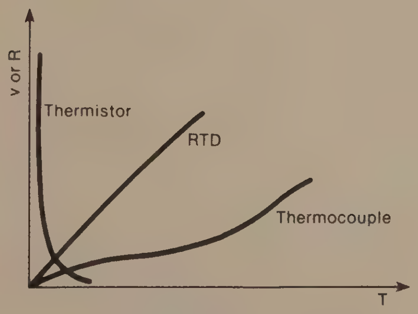

Figure 47

An individual thermistor curve can be very closely approximated through use of the Steinhart-Hart equation:[18]

$$\frac{1}{T} = A + B\ln R + C\,(\ln R)^3$$

where:

T = Degrees Kelvin
R = Resistance of the thermistor
A,B,C = Curve-fitting constants

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[6] Refer to Bibliography 6.

A, B, and C are found by selecting three data points on the published data curve and solving the three simultaneous equations. When the data points are chosen to span no more than 100°C within the nominal center of the thermistor's temperature range, this equation approaches a rather remarkable ±.02°C curve fit.

Somewhat faster computer execution time is achieved through a simpler equation:

$$T = \frac{B}{\ln R - A} - C$$

where A, B, and C are again found by selecting three (R,T) data points and solving the three resultant simultaneous equations. This equation must be applied over a narrower temperature range in order to approach the accuracy of the Steinhart-Hart equation.

Linear Thermistors

A great deal of effort has gone into the development of thermistors which approach a linear characteristic. These are typically 2- or 4-leaded devices requiring external matching resistors to linearize the characteristic curve. The modern data acquisition system with its computing controller has made this kind of hardware linearization unnecessary.

Measurement

The high resistivity of the thermistor affords it a distinct measurement advantage. The four-wire resistance measurement is not required as it is with RTD's. For example, a common thermistor value is 5000 ohms at 25°C. With a typical T.C. of 4%/°C, a measurement lead resistance of 10Ω produces only a .05°C error. This error is a factor of 500 times less than the equivalent RTD error.

Disadvantages – Because they are semiconductors, thermistors are more susceptible to permanent decalibration at high temperatures than are RTD's or thermocouples. The use of thermistors is generally limited to a few hundred degrees Celsius and manufacturers warn that extended exposures even well below maximum operating limits will cause the thermistor to drift out of its specified tolerance.

Thermistors can be made very small which means they will respond quickly to temperature changes. It also means that their small thermal mass makes them especially susceptible to self-heating errors.

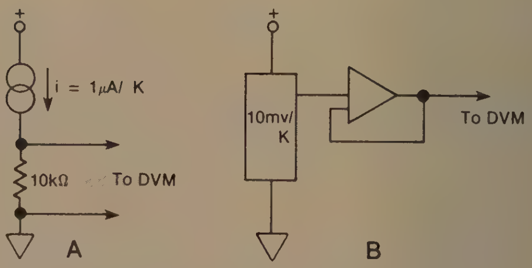
Thermistors are a good deal more fragile than RTD's or thermocouples and they must be carefully mounted to avoid crushing or bond separation.

MONOLITHIC LINEAR TEMPERATURE SENSOR

A recent innovation in thermometry is the integrated circuit temperature transducer. These are available in both voltage and current-output configurations. Both supply an output that is linearily proportional to absolute temperature. Typical values are 1 μA/K and 10 mV/K.

Except for the fact that they offer a very linear output with temperature, these devices share all the disadvantages of thermistors. They are semiconductor devices and thus have a limited temperature range. The same problems of self-heating and fragility are evident, and they require an external power source.

These devices provide a convenient way to produce an analog voltage proportional to temperature. Such a need arises in a hardware thermocouple reference junction compensation circuit, (see Figure 15).



CURRENT SENSOR VOLTAGE SENSOR

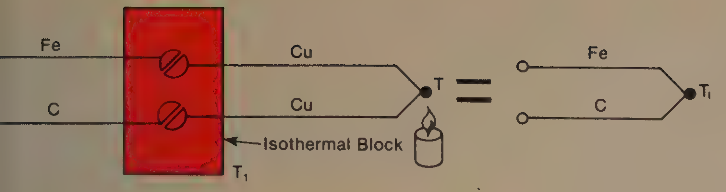
Figure 48

APPENDIX A

The Empirical Laws of Thermocouples[2]

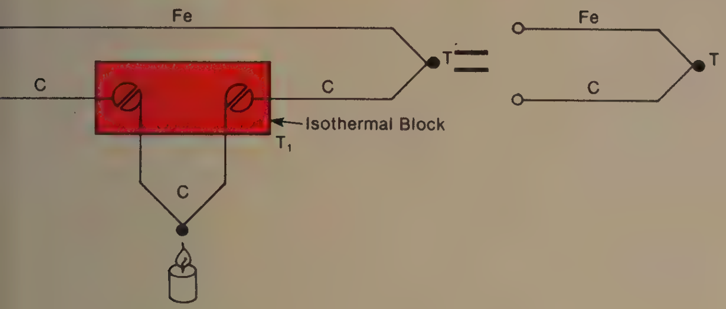
The following examples illustrate the empirically derived "laws" of thermocouples which are useful in understanding and diagnosing thermocouple circuits.

[2] Refer to Bibliography 2.



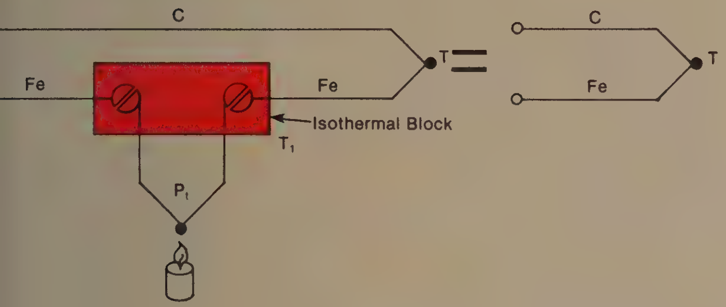
THE LAW OF INTERMEDIATE METALS

Inserting the copper lead between the iron and constantan leads will not change the output voltage V, regardless of the temperature of the copper lead. The voltage V is that of an Fe-C thermocouple at temperature T.



THE LAW OF INTERIOR TEMPERATURES

The output voltage V will be that of an Fe-C couple at Temperature T, regardless of the external heat source applied to either measurement lead.



THE LAW OF INSERTED METALS

The voltage V will be that of an Fe-C thermocouple at temperature T, provided both ends of the platinum wire are at the same temperature. The two thermocouples created by the platinum wire (Fe-P_t and P_t -Fe) act in opposition.

All of the above examples assume the measurement wires are homogeneous; that is, free of defects and impurities.

APPENDIX B

Thermocouple Characteristics

Over the years specific pairs of thermocouple alloys have been developed to solve unique measurement problems. Idiosyncrasies of the more common thermocouples are discussed here.

We will use the term *standard wire error* to refer to the common commercial specification published in the *Annual Book of ASTM Standards*. It represents the allowable deviation between the actual thermocouple output voltage and the voltage predicted by the tables in NBS Monograph 125.

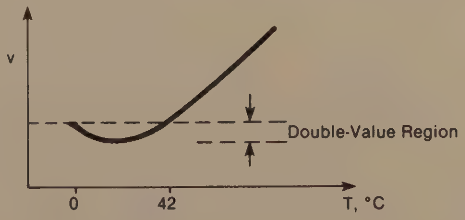
Noble Metal Thermocouples – The noble metal thermocouples, types B, R, and S, are all platinum or platinum-rhodium thermocouples and hence share many of the same characteristics.

Diffusion – Metallic vapor diffusion at high temperatures can readily change the platinum wire calibration, hence platinum wires should only be used inside a *non*-metallic sheath such as high-purity alumina. The one exception to this rule is a sheath made of platinum, and this option is prohibitively expensive.

Stability – The platinum-based couples are by far the most stable of all the common thermocouples. Type S is so stable that it is specified as the standard for temperature calibration between the antimony point (630.74°C) and the gold point (1064.43°C).

Type B – The B couple is the only common thermocouple that exhibits a double-valued ambiguity.

Due to the double-valued curve and the extremely low Seebeck coefficient at low temperatures, Type B is virtually useless below 50°C. Since the output is nearly zero from 0°C to 42°C, Type B has the unique advantage that the *reference* junction temperature is almost immaterial, as long as it is between 0° and 40°C. Of course, the *measuring* junction temperature is typically very high.



Base Metal Thermocouples

Unlike the noble metal thermocouples, the base metal couples have no specified chemical composition. Any combination of metals may be used which results in a voltage vs. temperature curve fit that is within the standard wire errors. This leads to some rather interesting metal combinations. *Constantan*, for example, is not a specific metal alloy at all, but a generic name for a whole series of copper-nickel alloys. Incredibly, the *Constantan* used in a type T (copper-Constantan) thermocouple is not the same as the *Constantan* used in the type J (iron-Constantan) couple.[3]

Type E – Although Type E standard wire errors are not specified below 0°C, the type E thermocouple is ideally suited for low temperature measurements because of its high Seebeck coefficient (58 V/°C), low thermal conductivity and corrosion resistance.

The Seebeck coefficient for Type E is greater than all other standard couples, which makes it useful for detecting small temperature changes.

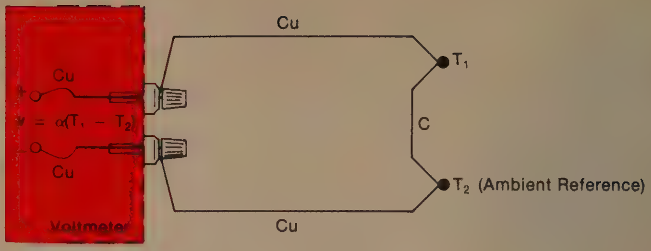
Type J - Iron, the positive element in a J couple, is an inexpensive metal rarely manufactured in pure form. J thermocouples are subject to poor conformance characteristics because of impurities in the iron. Even so, the J couple is popular because of its high Seebeck coefficient and low price.

The J couple should never be used above 760°C due to an abrupt magnetic transformation that can cause decalibration even when returned to lower temperatures.

Type T – This is the only couple with published standard wire errors for the temperature region below 0°C; however, type E is actually more suitable at very low temperatures because of its higher Seebeck coefficient and lower thermal conductivity.

Type T has the unique distinction of having one copper lead. This can be an advantage in a specialized monitoring situation where a temperature difference is all that is desired.

The advantage is that the copper thermocouple leads are the same metal as the dvm terminals, making lead compensation unnecessary.



TYPE T

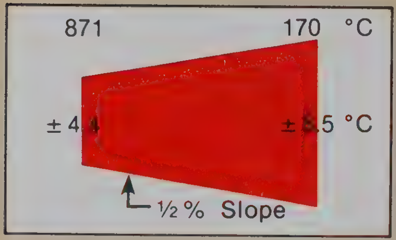
Types K & Nicrosil-Nisil – Type K has long been a popular thermocouple. It is especially suited to higher temperature applications due to its resistance to oxidation.

The Nicrosil-Nisil thermocouple is gaining popularity as a replacement for type K. It has a slightly lower output (smaller Seebeck coefficient) than type K, but an even higher resistance to oxidation. The Nicrosil-Nisil output curve is highly dependent upon wire size, and there are two distinct Nicrosil-Nisil characteristic curves published in NBS Monograph 161, the only difference being wire size.[14]

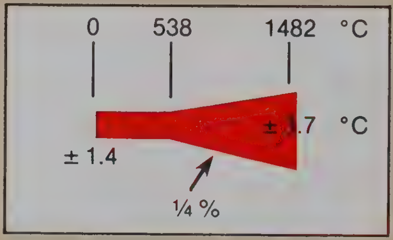
Tungsten - There is little information available for tungsten-based couples. Tungsten is very difficult to work due to its high melting point and brittleness, and it is difficult to seperate from impurities.

The Tungsten-Rhenium thermocouples are normally used only for very high temperature measurements (above 1000°C). There are no standard wire errors yet published for the Tungsten-Rhenium thermocouples, but some information is available from commercial suppliers.

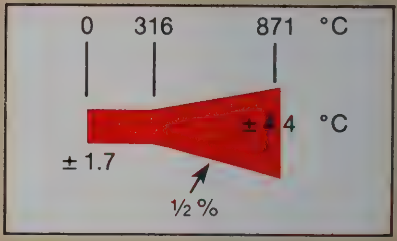
ASTM STANDARD WIRE ERRORS[3]



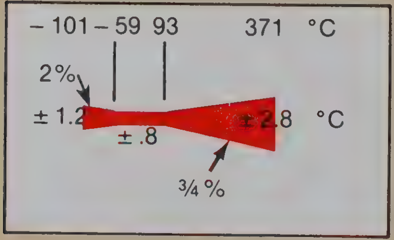
TYPE B 24 AWG



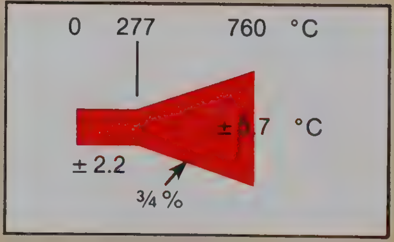
TYPES R,S 24 AWG



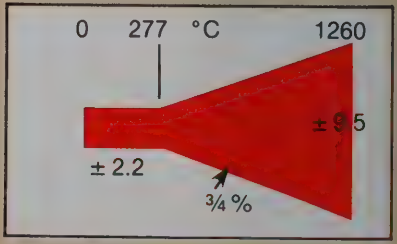
TYPE E 8 AWG



TYPE T 14 AWG



TYPE J 8 AWG



TYPE K 8 AWG

At high temperatures, small thermocouple wire is affected by diffusion, impurities, and inhomogeneity more so than large wire. The standard wire errors reflect this relationship.

Note that each NBS wire error specification carries with it a wire size. The noble metal thermocouples (B, R, and S) are specified with small (24 ga.) wire for obvious cost reasons.

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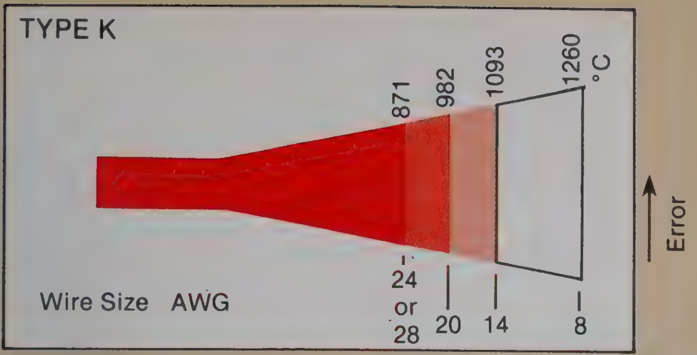
[3] Refer to Bibliography 3.

[14] Refer to Bibliography 14.



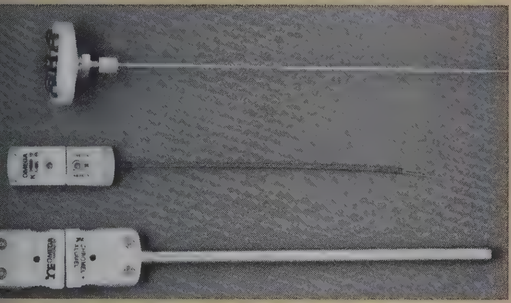
TEMPERATURE RANGE vs. WIRE SIZE vs. ERROR

AWG	DIA, MILS	DIA, mm
8	128	3.3
10	102	2.6
12	81	2.1
14	64	1.6
16	51	1.3
18	40	1
20	32	0.8
22	25	0.6
24	20	0.5
26	16	0.4
28	13	0.3

TYPE	METAL		STANDARD COLOR CODE		Ω/DOUBLE FOOT 20 AWG	SEEBECK COEFFICIENT S (μV/°C) @ T (°C)		°C STANDARD WIRE ERROR (SEE APPENDIX B)	NBS SPECIFIED MATERIAL RANGE† (°C)	3054A POLYNOMIAL FIT ERROR (°C)
	+	−	+	−		S	T			
B	Platinum – 6% Rhodium	Platinum – 30% Rhodium	–		0.2	6	600	4.4 – 8.6	0 to 1820*	.05 (130° – 1820°)
E	Nickel – 10% Chromium	Constantan	Violet	Red	0 71	58.5	0	1 7 – 4 4	– 270 to 1000	.07
J	Iron	Constantan	White	Red	0 36	50 2	0	1.1 – 2 9	– 210 to 760	015
K	Nickel – 10% Chromium	Nickel	Yellow	Red	0.59	39 4	0	1 1 – 2.9	– 270 to 1372	15
N (AWG 14)	Nicrosil	Nisil	–			39	600	–	0 to 1300	003
N (AWG 28)	Nicrosil	Nisil	–			26.2	0	–	– 270 to 400	06
R	Platinum – 13% Rhodium	Platinum	–		0 19	11 5	600	1.4 – 3 8	– 50 to 1768	025
S	Platinum – 10% Rhodium	Platinum	–		0 19	10 3	600	1 4 – 3 8	– 50 to 1768	02
T	Copper	Constantan	Blue	Red	0 30	38	0	0 8 – 2 9	– 270 to 400	.04
W-Re	Tungsten – 5% Rhenium	Tungsten – 26% Rhenium	–			19 5	600	–	0 to 2320	

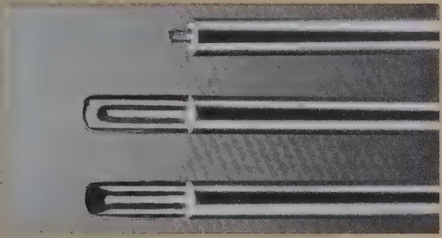
* *Type B double-valued below 42°C – curve fit specified only above 130°C.*

† *Material range is for 8 AWG wire and decreases with decreasing wire size.*



Connector. Composed of same metals as thermocouple, for minimum connection error.

Thermocouple Well. Lower gradient, protects wire, change Thermocouple without interrupting process.

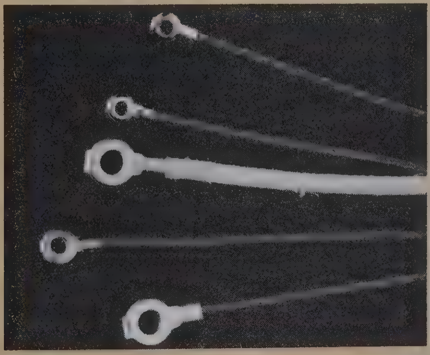


Exposed Junction. Wires unprotected, fastest response.

Ungrounded Junction. Best protection, electrically isolated.

Grounded Junction. Wires protected, faster response.

Thermocouple Washers. Couple built into washer, convenient mounting.



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Temperature Conversion Chart

Instructions For Use:

1. Start in the "Temp" column and find the temperature you wish to convert.
2. If the temperature to be converted is in degrees C, scan to the right column for the degrees F equivalent.
3. If the temperature to be converted is in degrees F, scan to the left column for the degrees C equivalent.

°C	TEMP.	°F	°C	TEMP.	°F	°C	TEMP.	°F
-101	-150	-238	-25	-13	8.6	-3.9	25	77
-95.6	-140	-220	-24.4	-12	10.4	-3.3	26	78.8
-90	-130	-202	-23.9	-11	12.2	-2.8	27	80.6
-84.4	-120	-184	-23.3	-10	14	-2.2	28	82.4
-78.9	-110	-166	-22.8	-9	15.8	-1.7	29	84.2
-73.3	-100	-148	-22.2	-8	17.6	-1.1	30	86
-67.8	-90	-130	-21.7	-7	19.4	-0.6	31	87.8
-62.2	-80	-112	-21.1	-6	21.2	0	32	89.6
-56.7	-70	-94	-20.6	-5	23	0.6	33	91.4
-51.1	-60	-76	-20	-4	24.8	1.1	34	93.2
-45.6	-50	-58	-19.4	-3	26.6	1.7	35	95
-40	-40	-40	-18.9	-2	28.4	2.2	36	96.8
-39.4	-39	-38.2	-18.3	-1	30.2	2.8	37	98.6
-38.9	-38	-36.4	-17.8	0	32	3.3	38	100.4
-38.3	-37	-34.6	-17.2	1	33.8	3.9	39	102.2
-37.8	-36	-32.8	-16.7	2	35.6	4.4	40	104
-37.2	-35	-31	-16.1	3	37.4	5	41	105.8
-36.7	-34	-29.2	-15.6	4	39.2	5.6	42	107.6
-36.1	-33	-27.4	-15	5	41	6.1	43	109.4
-35.6	-32	-25.6	-14.4	6	42.8	6.7	44	111.2
-35	-31	-23.8	-13.9	7	44.6	7.2	45	113
-34.4	-30	-22	-13.3	8	46.4	7.8	46	114.8
-33.9	-29	-20.2	-12.8	9	48.2	8.3	47	116.6
-33.3	-28	-18.4	-12.2	10	50	8.9	48	118.4
-32.8	-27	-16.6	-11.7	11	51.8	9.4	49	120.2
-32.2	-26	-14.8	-11.1	12	53.6	10	50	122
-31.7	-25	-13	-10.6	13	55.4	10.6	51	123.8
-31.1	-24	-11.2	-10	14	57.2	11.1	52	125.6
-30.6	-23	-9.4	-9.4	15	59	11.7	53	127.4
-30	-22	-7.6	-8.9	16	60.8	12.2	54	129.2
-29.4	-21	-5.8	-8.3	17	62.6	12.8	55	131
-28.9	-20	-4	-7.8	18	64.4	13.3	56	132.8
-28.3	-19	-2.2	-7.2	19	66.2	13.9	57	134.6
-27.8	-18	0.4	-6.7	20	68	14.4	58	136.4
-27.2	-17	1.4	-6.1	21	69.8	15	59	138.2
-26.7	-16	3.2	-5.6	22	71.6	15.6	60	140
-26.1	-15	5	-5.0	23	73.4	16.1	61	141.8
-25.6	-14	6.8	-4.4	24	75.2	16.7	62	143.6

CONVERSION FACTORS

°C = (°F − 32) × 5/9

°F = (°C × 9/5) + 32

0 Kelvin = −273.16°C

0° Rankine = −459.69°F

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Temperature Conversion Chart

°C	TEMP.	°F	°C	TEMP.	°F	°C	TEMP.	°F
17.2	63	145.4	43.3	110	230	254	490	914
17.8	64	147.2	48.9	120	248	260	500	932
18.3	65	149	54.4	130	266	288	550	1022
18.9	66	150.8	60	140	284	316	600	1112
19.4	67	152.6	65.6	150	302	343	650	1202
20	68	154.4	71.1	160	320	371	700	1292
20.6	69	156.2	76.7	170	338	399	750	1382
21.1	70	158	82.2	180	356	427	800	1472
21.7	71	159.8	87.8	190	374	454	850	1562
22.2	72	161.6	93.3	200	392	482	900	1652
22.8	73	163.4	98.9	210	410	510	950	1742
23.3	74	165.2	104	220	428	538	1000	1832
23.9	75	167	110	230	446	566	1050	1922
24.4	76	168.8	116	240	464	593	1100	2012
25	77	170.6	121	250	482	621	1150	2102
25.6	78	172.4	127	260	500	649	1200	2192
26.1	79	174.2	132	270	518	677	1250	2282
26.7	80	176	138	280	536	704	1300	2372
27.2	81	177.8	143	290	554	732	1350	2462
27.8	82	179.6	149	300	572	760	1400	2552
28.3	83	181.4	154	310	590	788	1450	2642
28.9	84	183.2	160	320	608	816	1500	2732
29.4	85	185	166	330	626	843	1550	2822
30	86	186.8	171	340	644	871	1600	2912
30.6	87	188.6	177	350	662	899	1650	3002
31.1	88	190.4	182	360	680	927	1700	3092
31.7	89	192.2	188	370	698	954	1750	3182
32.2	90	194	193	380	716	982	1800	3272
32.8	91	195.8	199	390	734	1010	1850	3362
33.3	92	197.6	204	400	752	1038	1900	3452
33.9	93	199.4	210	410	770	1066	1950	3542
34.4	94	201.2	216	420	788	1093	2000	3632
35	95	203	221	430	806	1149	2100	3812
35.6	96	204.8	227	440	824	1204	2200	3992
36.1	97	206.6	232	450	842	1260	2300	4172
36.7	98	208.4	238	460	860	1316	2400	4352
37.2	99	210.2	243	470	878	1371	2500	4532
37.8	100	212	249	480	896			

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Presenting . . . OMEGA's Temperature Measurement and Control Glossary

A comprehensive glossary of terms used in the field of temperature measurement and control. A helpful reference tool for scientists, engineers, and technicians!

Absolute zero: Temperature at which thermal energy is at a minimum. Defined as O Kelvin, calculated to be −273.16°C or −459.69°F.

ac: Alternating current.

Accuracy: Closeness of a reading or indication of a measurement device to the actual value of the quantity being measured.

Alloy 11: A compensating alloy used in conjunction with pure copper as the negative leg to form extension wire for platinum — platinum rhodium thermocouples Types R and S.

Alloy 200/226: The combination of compensating alloys used with tungsten vs. tungsten 26% rhenium thermocouples as extension cable for applications under 200° C.

Alloy 203/225: The combination of compensating alloys used with tungsten 3% rhenium vs. tungsten 25% rhenium thermocouples as extension cable for applications under 200° C.

Alloy 405/426: The combination of compensating alloys used with tungsten 5% rhenium vs. tungsten 26% rhenium thermocouples as extension cable for applications under 870°C.

Alpha (α): The average percent change in resistance per degree of a pure metal resistance device between 0° and 100° C. Usually designated by the Greek letter alpha, α with units of ohm/ohm/° C. The common alpha for a platinum RTD is 0.00385 ohm/ohm/° C.

Alumel: An aluminum nickel alloy used in the negative leg of a Type K thermocouple (Trade name of Hoskins Manufacturing Company).

Ambient compensation: The design of an instrument such that changes in ambient temperature do not affect the readings of the instrument.

Ambient temperature: The average or mean temperature of the surrounding air which comes in contact with the equipment and instruments under test.

Ampere (amp): A unit used to define the rate of flow of electricity (current) in a circuit; units are one coulomb (6.25×10^{18} electrons) per second.

Ammeter: An instrument used to measure current.

Angstrom: Ten to the minus tenth meters (10^{-10}) or one millimicron, a unit used to define the wave length of light. Designated by the symbol Å.

Anti-reset windup: This is a feature in a three-mode PID controller which prevents the integral (auto reset) circuit from functioning when the temperature is outside the proportional band.

Automatic reset: 1. A feature on a limit controller that automatically resets the controller when the controlled temperature returns to within the limit bandwidth set. 2. The integral function on a PID controller which adjusts the proportional bandwidth with respect to the set point to compensate for droop in the circuit, i.e., adjusts the controlled temperature to the set point after the system stabilizes.

ANSI: American National Standards Institute.

AWG: American Wire Gauge.

Bandwidth: A symmetrical region around the set point in which proportional control occurs.

Beryllia: BeO (Beryllium Oxide) A high-temperature mineral insulation material; toxic when in powder form.

Blackbody: A theoretical object that radiates the maximum amount of energy at a given temperature, and absorbs all the energy incident upon it. A blackbody is not necessarily black. (The name blackbody was chosen because the color black is defined as the total absorption of light [energy].)

Boiling point: The temperature at which a substance in the liquid phase transforms to the gaseous phase; commonly refers to the boiling point of water which is 100° C (212° F) at sea level.

Btu: British Thermal Unit. The quantity of thermal energy required to raise one pound of water 1° F at or near its maximum density (39.1° F).

Bulb (liquid-in-glass thermometer): The area at the tip of a liquid-in-glass thermometer containing the liquid reservoir.

Burst proportioning: A fast-cycling output form on a time proportioning controller (typically adjustable from .2 to 4 seconds) used in conjunction with a solid state relay to prolong the life of heaters by minimizing thermal stress.

Calender-van Dusen equation: An equation that defines the resistance-temperature value of any pure metal that takes the form of $R_T = R_O (1 + AT + BT^2)$ for values between the ice point (0°C) and the freezing point of antimony (630.7°C) and the form $R_T = R_O [1 + AT + BT^2 + C (T\text{-}100)T^2]$ between the oxygen point (−183.0°C) and the ice point (0°C).

Calibration: The process of adjusting an instrument or compiling a deviation chart so that its reading can be correlated to the actual value being measured.

Calorie: The quantity of thermal energy required to raise one gram of water 1° C at 15° C.

Celsius (Centigrade): A temperature scale defined by 0° C at the ice point and 100° at the boiling point of water.

Ceramic insulation: High-temperature compositions of metal oxides used to insulate a pair of thermocouple wires. The most common are Alumina (Al_2O_3), Beryllia (BeO), and Magnesia (MgO). Their application depends upon temperature and type of thermocouple. High-purity Alumina is required for platinum alloy thermocouples. Ceramic insulators are available as single and multihole tubes or as beads.

Chatter: The rapid cycling on and off of a relay in a control process due to insufficient bandwidth in the controller.

Chromel: A chromium-nickel alloy which makes up the positive leg of Type K and Type E thermocouples (Trade name of Hoskins Manufacturing Company).

Closeness of control: Total temperature variation from a desired set point of system. Expressed as "closeness of control" is ±2° C or a system bandwidth with 4° C, also referred to as amplitude of deviation.

Color code: The ANSI established color code for thermocouple wires in the negative lead is always red. Color Code for base metal thermocouples is yellow for Type K, black for Type J, purple for Type E and blue for Type T.

Common-mode rejection ratio: The ability of an instrument to reject interference from a common voltage at its input terminals with relation to ground, usually expressed in dB (decibels).

Compensating alloys: Alloys used to connect thermocouples to instrumentation. These alloys are selected to have similar thermal electric properties as the thermocouple alloys (however, only over a very limited temperature range).

Compensated connector: A connector made of thermocouple alloys used to connect thermocouple probes and wires.

Compensating loop: Lead wire resistance compensation for RTD elements where an extra length of wire is run from the instrument to the RTD and back to the instrument, with no connection to the RTD.

Connection head: An enclosure attached to the end of a thermocouple which can be cast iron, aluminum or plastic within which the electrical connections are made.

Constantan: A copper-nickel alloy used as the negative lead in Type E, Type J, and Type T thermocouples.

Control mode: The output form or type of control action used by a temperature controller to control temperature, i.e., on/off, time proportioning, PID.

Control point: The temperature at which a system is to be maintained.

cps: Cycles per second. See Hertz.

Cryogenics: Measurement of temperature at extremely low values, i.e., below -200° C.

Curie point: The temperature at which a normally magnetic material goes through a magnetic transformation and becomes non-magnetic.

Current: The rate of flow of electricity. The unit is the ampere (A) defined as 1 ampere = I coulomb per second.

Current proportioning: An output form of a temperature controller which provides a current proportional to the amount of control required. Normally is a 4-20 milliamp current proportioning band.

Cycle time: The time usually expressed in seconds for a controller to complete one on/off cycle.

dc: Direct current.

Dead band: 1. For chart records: the minimum change of input signal required to cause a deflection in the pen position. 2. For temperature controllers: the temperature band where heat is turned off upon rising temperature and turned on upon falling temperature expressed in degrees. The area where no heating (or cooling) takes place.

Degree: An incremental value in the temperature scale, i.e., there are 100 degrees between the ice point and the boiling point of water in the Celsius scale and 180° F between the same two points in the Fahrenheit scale.

Deviation: The difference between the value of the controlled variable and the value at which it is being controlled.

Differential: For an on/off controller, it refers to the temperature difference between the temperature at which the controller turns heat off and the temperature at which the heat is turned back on. It is expressed in degrees.

DIN: Deutsche Industrial Norms. A German agency that sets engineering and dimensional standards that now has worldwide recognition.

DIN 43760: The standard that defines the characteristics of a 100 ohm platinum RTD having a resistance vs. temperature curve specified by $\alpha = 0.00385$ ohms per ohms per degree C.

Dissipation constant: The ratio for a thermistor which relates a change in internal power dissipation to a resultant change of body temperature.

Drift: A change of a reading or a set point value over long periods due to several factors including change in ambient temperature, time, and line voltage.

Droop: A common occurrence in time-proportional controllers. It refers to the difference in temperature between the set point and where the system temperature actually stabilizes due to the time-proportioning action of the controller.

Dual element sensor: A sensor assembly with two independent sensing elements.

Duplex wire: A pair of wires insulated from each other and with an outer jacket of insulation around the inner insulated pair.

Duty cycle: The total time to complete one on/off cycle. Usually refers to the on/off cycle time of a temperature controller.

Electrical interference: Electrical noise induced upon the signal wires that obscures the wanted information signal.

emf: Electomotive force. A rise in (electrical) potential energy. The principal unit is the volt.

EMI: Electromagnetic interference.

Emissivity: The ratio of energy emitted by an object to the energy emitted by a blackbody at the same temperature. The emissivity of an object depends upon its material and surface texture; a polished metal surface can have an emissivity around 0.2, and a piece of wood can have an emissivity around 0.95.

Endothermic: Absorbs heat. A process is said to be *endothermic* when it absorbs heat.

Error: The difference between the correct or desired value and the actual reading or value taken.

Eutectic temperature: The lowest possible melting point of a mixture of alloys.

Exothermic: Gives off heat. A process is said to be *exothermic* when it releases heat.

Explosion-proof enclosure: An enclosure that can withstand an explosion of gases within it and prevent the explosion of gases surrounding it due to sparks, flashes or the explosion of the container itself, and maintain an external temperature which will not ignite the surrounding gases.

Exposed junction: A form of construction of a thermocouple probe where the hot or measuring junction protrudes beyond the sheath material so as to be fully exposed to the medium being measured. This form of construction usually gives the fastest response time.

Fahrenheit: A temperature scale defined by 32° at the ice point and 212° at the boiling point of water at sea level.

Ferrule: A compressible tubular fitting that is compressed onto a probe inside a compression fitting to form a gas-tight seal.

Field of view: A volume in space defined by an angular cone extending from the focal plane of the instrument.

FM: Factory Mutual Research Corp. An organization which sets industrial safety standards.

FM-approved: An instrument that meets a specific set of specifications established by Factory Mutual Research Corp.

Freezing point: The temperature at which the substance goes from the liquid phase to the solid phase.

Frequency: The number of cycles over a specified time period over which an event occurs. The reciprocal is called the *period.*

Gain: The amount of amplification used in an electrical circuit.

Galvanometer: An instrument that measures small electrical currents by means of deflecting magnetic coils.

Ground: 1. The electrical neutral line having the same potential as the surrounding earth. 2. The negative side of dc power supply. 3. Reference point for an electrical system.

Grounded junction: A form of construction of a thermocouple probe where the hot or measuring junction is in electrical contact with the sheath material so that the sheath and thermocouple will have the same electrical potential.

Heat: Thermal energy. Heat is expressed in units of calories or Btu's.

Heat sink: 1. Thermodynamic. A body which can absorb thermal energy. 2. Practical. A finned piece of metal used to dissipate the heat of solid state components mounted on it.

Heat transfer: The process of thermal energy flowing from a body of high energy to a body of low energy. Means of transfer are: Conduction, the two bodies in contact; Convection, a form of conduction where the two bodies in contact are of different phases, i.e., solid and gas; Radiation, all bodies emit infrared radiation.

Heat treating: A process for treating metals where heating to a specific temperature and cooling at a specific rate changes the properties of the metal.

Hertz (Hz): Units in which frequency is expressed. Synonymous with cycles per second.

ISA: Instrument Society of America.

Ice point: The temperature at which pure water freezes, 0° C, 32° F, 273.16K.

Impedance: The total opposition to electrical flow (resistive plus reactive).

Infrared: An area in the electromagnetic spectrum extending beyond red light from 760 nanometers to 1000 microns (10^6 nm). It is the form of radiation used for making non-contact temperature measurements.

Insulated junction: See ungrounded junction.

Insulation resistance: The resistance value of the cover material of an electrical conductor, expressed in ohms.

Integral: A form of temperature control. See automatic reset, #2.

Interchangeability error: A measurement error that can occur if two or more probes are used to make the same measurement. It is caused by a slight variation in characteristics of different probes.

Intrinsically safe: An instrument which will not produce any spark or thermal effects under normal or abnormal conditions that will ignite a specified gas mixture.

IPTS-48: International Practical Temperature Scale of 1948. Fixed points in thermometry as specified by the Ninth General Conference of Weights and Measures which was held in 1948.

IPTS-68: International Practical Temperature Scale of 1968. Fixed points in thermometry set by the 1968 General Conference of Weights and Measures.

Isothermal: A process or area that is at a constant temperature.

Joule: The basic unit of thermal energy.

Junction: The point in a thermocouple where the two dissimilar metals are joined.

Kelvin: Symbol K. The unit of absolute or thermodynamic temperature scale based upon the Celsius scale with 100 units between the ice point and boiling point of water. 0° C = 273.16K (there is no degree (°) symbol used with the Kelvin scale).

KVA: Kilovolt amperes (1000-volt amps).

Lag: 1. A time delay between the output of a signal and the response of the instrument to which the signal is sent. 2. A time relationship between two waveforms where a fixed reference point on one wave occurs after the same point of the reference wave.

Limits of error: A tolerance band for the thermal electric response of thermocouple wire expressed in degrees or percentage defined by ANSI specification MC-96.1 (1975).

Linearity: A deviation of an instrument's response from a straight line.

Load: The electrical demand of a process expressed as power (watts), current (amps) or resistance (ohms).

Loop resistance: The total resistance of a thermocouple circuit caused by the resistance of the thermocouple wire. Usually used in reference to analog pyrometers which have typical loop resistance requirements of 10 ohms.

Manual reset (adjustment): The adjustment on a proportioning controller which shifts the proportioning band in relationship to the set point to eliminate droop or offset errors.

Manual reset (switch): The switch in a limit controller that manually resets the controller after the limit has been exceeded.

Maximum operating temperature: The maximum temperature at which an instrument or sensor can be safely operated.

Maximum power rating: The maximum power in watts that a device can safely handle.

Mean temperature: The average of the maximum and minimum temperatures of a process at equilibrium.

Measuring junction: The thermocouple junction referred to as the hot junction that is used to measure an unknown temperature.

Melting point: The temperature at which a substance transforms from a solid phase to a liquid phase.

Mica: A transparent mineral used as window material in high-temperature ovens.

Microamp: One millionth of an ampere, 10^{-6} amps.

Micron: One millionth of a meter, 10^{-6} meters.

Microvolt: One millionth of a volt, 10^{-6} volts.

Mil: One thousandth of an inch (.001").

Milliamp: One thousandth of an amp, 10^{-3} amps, symbol mA.

Millimeter: One thousandth of a meter, symbol mm.

Millivolt: One thousandth of a volt, symbol mV.

Mineral-insulated thermocouple: A type of thermocouple cable which has an outer metal sheath and mineral (magnesium oxide) insulation inside separating a pair of thermocouple wires from themselves and from the outer sheath. This cable is usually drawn down to compact the mineral insulation and is available in diameters from .375 to .010 inches. It is ideally suited for high-temperature and severe-duty applications.

Minor scale division: On an analog scale, the smallest indicated division of units on the scale.

Mueller bridge: A high-accuracy bridge configuration used to measure three-wire RTD thermometers.

Negative temperature coefficient: A decrease in resistance with an increase in temperature.

Nicrosil/nisil: A nickel chrome/nickel silicone thermal alloy used to measure high temperatures. Inconsistencies in thermoelectric voltages exist in these alloys with respect to the wire gage.

Noise: An unwanted electrical interference on the signal wires.

Normal-mode rejection ratio: The ability of an instrument to reject interference usually of line frequency (50-60 Hz) across its input terminals.

NPT: National Pipe Thread.

O.D.: Outside diameter.

Offset: The difference in temperature between the set point and the actual process temperature. Also, referred to as *droop*.

ofhc: Oxygen-free high-conductivity copper. The industrial designation of the pure copper used in a Type T thermocouple.

Ohmeter: An instrument used to measure electrical resistance.

On/off controller: A controller whose action is fully on or fully off.

Optical isolation: Two networks which are connected only through an LED transmitter and photoelectric receiver with no electrical continuity between the two networks.

Overshoot: The number of degrees that a process exceeds the set point temperature when coming up to the set point temperature.

Parallax: An optical illusion which occurs in analog meters and causes reading errors. It occurs when the viewing eye is not in the same plane, perpendicular to the meter face, as the indicating needle.

Peltier effect: When a current flows through a thermocouple junction, heat will either be absorbed or evolved depending on the direction of current flow. This effect is independent of Joule I^2R heating.

Phase: A time-based relationship between a periodic function and a reference. In electricity, it is expressed in angular degrees to describe the voltage or current relationship of two alternating waveforms.

Phase difference: The time expressed in degrees between the same reference point on two periodic waveforms.

Phase proportioning: A form of temperature control where the power supplied to the process is controlled by limiting the phase angle of the line voltage.

PID: Proportional, Integral, Derivative. A three-mode control action where the controller has time proportioning, integral (auto reset), and derivative action.

Platinel: A non-standard, high temperature platinum thermocouple alloy whose thermoelectric voltage nearly matches a Type K thermocouple (Trademark of Englehard Industries).

Platinum: A noble metal which in its pure form is the negative wire of Type R and Type S thermocouples.

Platinum 6% rhodium: The platinum-rhodium alloy used as the negative wire in conjunction with platinum-30% rhodium to form a Type B thermocouple.

Platinum 10% rhodium: The platinum-rhodium alloy used as the positive wire in conjunction with pure platinum to form a Type S thermocouple.

Platinum 13% rhodium: The platinum-rhodium alloy used as the positive wire in conjunction with pure platinum to form a Type R thermocouple.

Platinum 30% rhodium: The platinum-rhodium alloy used as the positive wire in conjunction with platinum 6% rhodium to form a Type B thermocouple.

Platinum 67: To develop thermal emf tables for thermocouples, the National Bureau of Standards paired each thermocouple alloy against a pure platinum wire (designated Platinum 27 prior to 1973, and currently Platinum 67). The thermal emf's of any alloy combination can be determined by summing the "vs. Pt-67" emf's of the alloys, i.e., the emf table for a Type K thermocouple is derived from the Chromel vs. Pt-67 and the Alumel vs. Pt-67 values.

Polarity: In electricity, the quality of having two oppositely charged poles, one positive and one negative.

Positive temperature coefficient: An increase in resistance due to an increase in temperature.

Potentiometer: 1. A variable resistor often used to control a circuit. 2. A balancing bridge used to measure voltage.

Power supply: A separate unit or part of a circuit that supplies power to the rest of the circuit or to a system.

Primary standard (NBS): The standard reference units and physical constants maintained by the National Bureau of Standards upon which all measurement units in the United States are based.

Probe: A generic term that is used to describe many types of temperature sensors.

Proportioning band: A temperature band expressed in degrees within which a temperature controller's time proportioning function is active.

Proportioning control mode: A time-proportioning controller where the amount of time that the relay is energized is dependent upon the system's temperature.

Proportioning control plus derivative function: A time-proportioning controller with a derivative function. The derivative function senses the rate at which a system's temperature is either increasing or decreasing and adjusts the cycle time of the controller to minimize overshoot or undershoot.

Proportioning control plus integral: A two-mode controller with time proportioning and integral (auto reset) action. The integral function automatically adjusts the temperature at which a system has stabilized back to the set point temperature, thereby eliminating droop in the system.

Proportioning control with integral and derivative functions: Three-mode PID controller. A time-proportioning controller with integral and derivative functions. The integral function automatically adjusts the system temperature to the set point temperature to eliminate droop due to the time-proportioning function. The derivative function senses the rate of rise or fall of the system temperature and automatically adjusts the cycle time of the controller to minimize overshoot or undershoot.

Protection head: An enclosure usually made out of metal at the end of a probe where connections to the probe are made.

Protection tube: A metal or ceramic tube, closed at one end into which a temperature sensor is inserted. The tube protects the sensor from the medium into which it is inserted.

Radiation: See *Infrared.*

Range: An area between two limits within which a quantity is measured. It is usually expressed by stating the lower limit first and then the upper limit.

Rankine (°R): An absolute temperature scale based upon the Fahrenheit scale with 180° between the ice point and boiling point of water. 459.69°R = 0°F.

Rate action: The derivative function of a temperature controller.

Rate time: The time interval over which the system temperature is sampled for the derivative function.

Reference junction: The cold junction in a thermocouple circuit which is held at a stable known temperature. The standard reference temperature is 0° C (32° F); however, other temperatures can be used.

Refractory metal thermocouple: A class of thermocouples with melting points above 3600° F. The most common are made from tungsten and tungsten/rhenium alloys Types G and C. They can be used for measuring high temperatures up to 4000° F (2200° C) in non-oxydizing, inert, or vacuum environments.

RFI: Radio frequency interference.

Relay (mechanical): An electromechanical device that completes or interrupts a circuit by physically moving electrical contacts into contact with each other.

Relay (solid state): A solid state switching device which completes or interrupts a circuit electrically with no moving parts.

Reostat: A variable resistor.

Repeatability: The ability of a probe or instrument to give the same output or reading under repeated identical conditions.

Resistance: The resistance to the flow of electric current measured in ohms (Ω). For a conductor resistance is a functon of diameter, resistivity (an intrinsic property of the material) and length.

Resistance ratio characteristic: For thermistors, the ratio of the resistance of the thermistor at 25° C to the resistance at 125° C.

Resistance temperature characteristic: A relationship between a thermistor's resistance and the temperature.

Response time (Time Constant): The time required by a sensor to reach 63.2% of a step change in temperature under a specified set of conditions. Five time constants are required for the sensor to stabilize at 100% of the step change value.

RTD: Resistance temperature detector.

SAMA: Scientific Apparatus Makers Association. An association that has issued standards covering platinum, nickel, and copper resistance elements (RTD's).

SCR: Silicon controlled rectifier.

Seebeck coefficient: The derivative (rate of change) of thermal emf with respect to temperature normally expressed as millivolts per degree.

Seebeck effect: When a circuit is formed by a junction of two dissimilar metals and the junctions are held at different temperatures, a current will flow in the circuit caused by the difference in temperature between the two junctions.

Seebeck emf: The open circuit voltage caused by the difference in temperature between the hot and cold junctions of a circuit made from two dissimilar metals.

Secondary standard: A standard of unit measurement derived from a primary standard.

Sensitivity: The minimum change in input signal to which an instrument can respond.

Set point: The temperature at which a controller is set to control a system.

Sheath thermocouple: A thermocouple made out of mineral-insulated thermocouple cable which has an outer metal sheath.

SI: System Internationale. The name given to the standard metric system of units.

Signal: An electrical transmittance (either input or output) that conveys information.

Span: The difference between the upper and lower limits of a range expressed in the same units as the range.

Specific gravity: The ratio of mass of any material to the mass of the same volume of pure water at 4° C.

Specific heat: The ratio of thermal energy required to raise the temperature of a body 1° to the thermal energy required to raise an equal mass of water 1°.

Spectral filter: A filter which allows only a specific band width of the electromagnetic spectrum to pass, i.e., 4 to 8 micron infrared radiation.

Spot size: The diameter of the circle formed by the cross section of the field of view of an optical instrument at a given distance.

SSR: Solid state relay (see *relay, solid state*).

Stability: The quality of an instrument or sensor to maintain a consistent output when a constant input is applied.

Super cooling: The cooling of a liquid below its freezing temperature without the formation of the solid phase.

Super heating: 1. The heating of a liquid above its boiling temperature without the formation of the gaseous phase. 2. The heating of the gaseous phase considerably above the boiling-point temperature to improve the thermodynamic efficiency of a system.

Surge current: A current of short duration that occurs when power is first applied to capacitive loads or temperature-dependent resistive loads such as tungsten or molybdenum heaters — usually lasting no more than several cycles.

Teflon: A fluorocarbon polymer used for insulation of electrical wires (trademark of DuPont Company).

Thermal conductivity: The property of a material to conduct heat in the form of thermal energy.

Thermal emf: See *Seebeck emf.*

Thermal expansion: An increase in size due to an increase in temperature expressed in units of an increase in length or increase in size per degree, i.e., inches/inch/degree C.

Thermal gradient: The distribution of a differential temperature through a body or accross a surface.

Thermistor: A temperature-sensing element composed of sintered semiconductor material which exhibits a large change in resistance proportional to a small change in temperature. Thermistors usually have negative temperature coefficients.

Thermocouple: The junction of two dissimilar metals which has a voltage output proportional to the difference in temperature between the hot junction and the lead wires (cold junction) (refer to *Seebeck emf*). Standard thermocouple types are:

Thermocouple Type (ANSI Symbol)	**Material**
J	Iron/Constantan
K	Chromel/Alumel
T	Copper/Constantan
E	Chromel/Constantan
R	Platinum/Platinum 13% Rhodium
S	Platinum/Platinum 10% Rhodium
B	Platinum 6% Rhodium/Platinum 30% Rhodium
G*	Tungsten/Tungsten 26% Rhenium
C*	Tungsten 5% Rhenium/Tungsten 26% Rhenium
D*	Tungsten 3% Rhenium/Tungsten 25% Rhenium

*Not ANSI symbols

Thermopile: An arrangement of thermocouples in series such that alternate junctions are at the measuring temperature and the reference temperature. This arrangement amplifies the thermoelectric voltage. Thermopiles are usually used as infrared detectors in radiation pyrometry.

Thermowell: A closed-end tube designed to protect temperature sensors from harsh environments, high pressure, and flows. They can be installed into a system by pipe thread or welded flange and are usually made of corrosion-resistant metal or ceramic material depending upon the application.

Thomson effect: When current flows through a conductor within a thermal gradient, a reversible absorption or evolution of heat will occur in the conductor at the gradient boundaries.

Transducer: A device which converts the parameter being measured into another form which is its output. Example, a thermocouple transforms heat into a millivolt output.

Transmitter (two-wire): A device which is used to transmit temperature data from either a thermocouple or RTD via a two-wire current loop. The loop has an external power supply and the transmitter acts as a variable resistor with respect to its input signal.

Triac: A solid state switching device used to switch alternating current wave forms.

Triple point (water): The thermodynamic state where all three phases, solid, liquid, and gas may all be present in equilibrium. The triple point of water is at .01° C.

TTL: Transistor-to-transistor logic. A form of solid state logic which uses only transistors to form the logic gates.

UL: Underwriters Laboratories, Inc. An independent laboratory that establishes standards for commercial and industrial products.

Ultraviolet: That portion of the electromagnetic spectrum below blue light (380 nanometers).

Undershoot: The difference in temperature between the temperature a process goes to, below the set point, after the cooling cycle is turned off and the set point temperature.

Ungrounded junction: A form of construction of a thermocouple probe where the hot or measuring junction is fully enclosed by and insulated from the sheath material.

Union: A form of pipe fitting where two extension pipes are joined at a separable coupling.

Volt: The (electrical) potential difference between two points in a circuit. The fundamental unit is derived as work per unit charge — (V-W/Q). One volt is the potential difference required to move one coulomb of charge between two points in a circuit while using one joule of energy.

Voltage: An electrical potential which can be measured in volts.

Voltmeter: An instrument used to measure voltage.

Working standard: A standard of unit measurement calibrated from either a primary or secondary standard which is used to calibrate other devices or make comparison measurements.

Wheatstone bridge: A network of four resistances, an emf source, and a galvanometer connected such that when the four resistances are matched, the galvanometer will show a zero deflection or "null" reading.

Zero offset: 1. The difference expressed in degrees between true zero and an indication given by a measuring instrument. 2. *See zero suppression.*

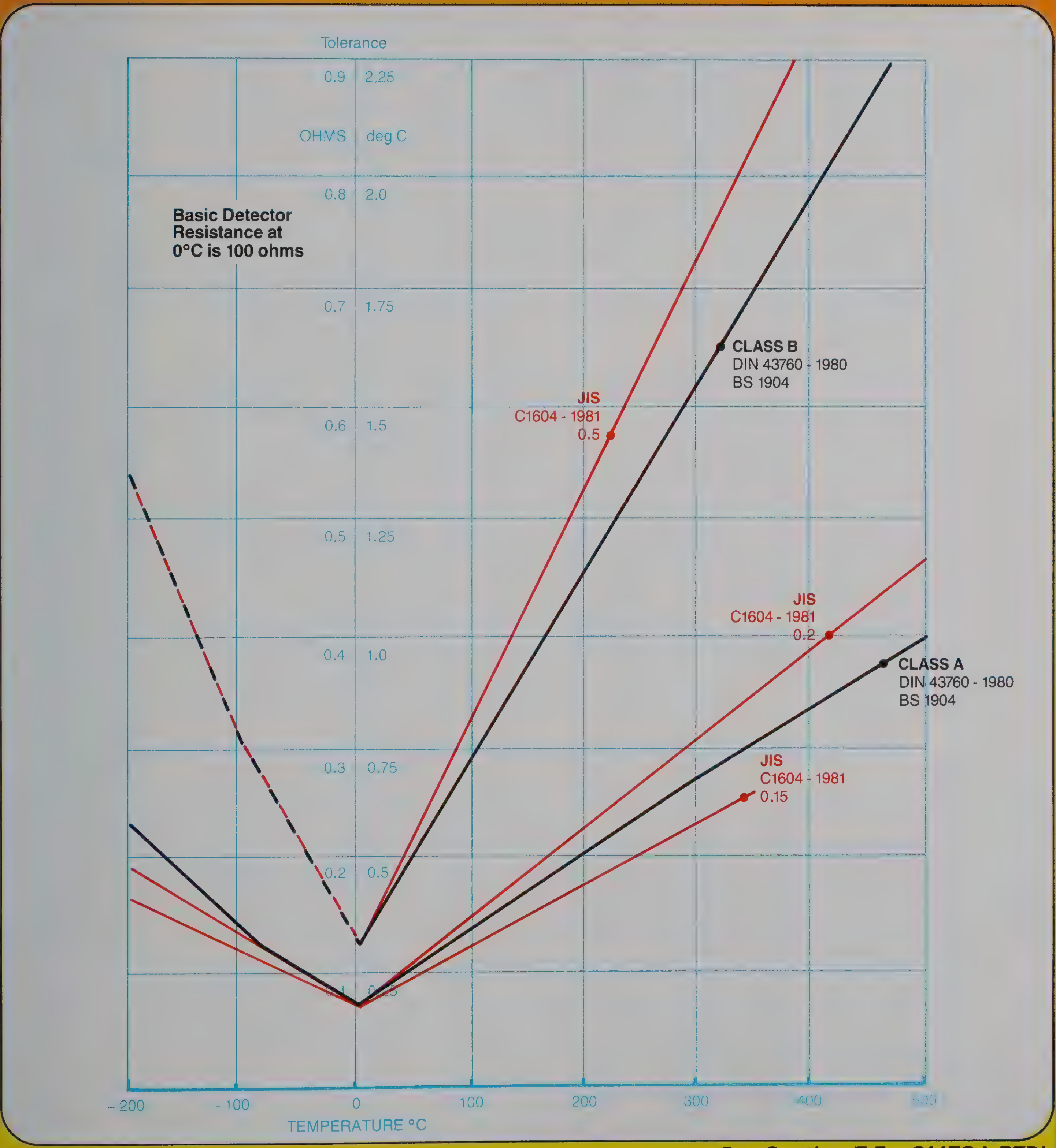
Zero power resistance: The resistance of a thermistor or RTD element with no power being dissipated.

Zero suppression: The span of an indicator or chart recorder may be offset from zero (zero suppressed) such that neither limit of the span will be zero. Example, a temperature recorder which records a 100° span from 400° to 500° is said to have 400% zero suppression.

Zero voltage switching: The making or breaking of circuit timed such that the transition occurs when the voltage wave form crosses zero voltage; typically only found in solid state switching devices.

Platinum Resistance Temperature Detectors

Detector Interchangeability Tolerance Chart



*See **Section E** For OMEGA RTD's.*

Reference Guide

Identification

Color Coding

Standard ANSI color coding is used on all insulated thermocouples wire and extension grade wire when the insulation permits. For some insulations a colored tracer is used to distinguish the calibration.

ANSI Letter Designations

Thermocouple and extension grade wires are specified by ANSI letter designations. Positive and negative legs are identified by the letter suffixes P and N respectively. Example: JP designates the positive leg (iron) of the Iron-Constantan pair.

CHARACTERISTICS TABLE

ANSI T/C	Symbol Single	Generic and Trade Names	Color Coding			Magnetic		Maximum Useful Temp. Range	EMF (MV) Over Useful Temp. Range	Average Sensitivity $\mu V/°C$	Environment (Bare Wire)
			Single	Overall T/C Wire	Overall Extension Grade Wire	Yes	No				
T	TP TN	Copper Constantan, Cupron, Advance	Blue Red	Brown	Blue		X X	°F -328 to 662 °C -200 to 350	-5.602 to 17.816	40.5	Mild Oxidizing, Reducing. Vacuum or Inert. Good where moisture is present.
J	JP JN	Iron Constantan, Cupron, Advance	White Red	Brown	Black	X	 X	°F 32 to 1382 °C 0 to 750	0 to 42.283	52.6	Reducing. Vacuum, Inert. Limited use in oxidizing at High Temperatures. Not recommended for low temps.
E	EP EN	Chromel, Tophel, T^1 Thermokanthal KP Constantan, Cupron, Advance	Purple Red	Brown	Purple		X X	°F -328 to 1652 °C -200 to 900	-8.824 to 68.783	67.9	Oxidizing or Inert. Limited use in Vacuum or Reducing.
K	KP KN	Chromel, Tophel, T^1 Thermokanthal KP Alumel, Nial, T^2 Thermokanthal KN	Yellow Red	Brown	Yellow	 X	X 	°F -328 to 2282 °C -200 to 1250	-5.973 to 50.633	38.8	Clean Oxidizing and Inert. Limited use in Vacuum or Reducing.
S	SP SN	Platinum 10% Rhodium Pure Platinum	Black Red		Green		X X	°F 32 to 2642 °C 0 to 1450	0 to 14.973	10.6	Oxidizing or Inert Atmos. Do not insert in metal tubes. Beware of contamination.
R	RP RN	Platinum 13% Rhodium Pure Platinum	Black Red		Green		X X	°F 32 to 2642 °C 0 to 1450	0 to 16.741	12.0	
B	BP BN	Platinum 30% Rhodium Platinum 6% Rhodium	Gray Red		Gray		X X	°F 32 to 3092 °C 0 to 1700	0 to 12.426	7.6	
C*	CP* CN*	Tunsten 5% Rhenium Tungsten 26% Rhenium	White/Red Trace Red		White/Red Trace		X X	°F 32 to 4208 °C 0 to 2320	0 to 37.066	16.6	Vacuum, Inert, Hydrogen Atmospheres. Beware of embrittlement.
G*	GP* GN*	Tungsten Tungsten 26% Rhenium	White/Blue Trace Red		White/Blue Trace		X X	°F 32 to 4208 °C 0 to 2320	0 to 38.564	16.0	
D*	DP* DN*	Tungsten 3% Rhenium Tungsten 25% Rhenium	White/Yellow Trace Red		White/Yellow Trace		X X	°F 32 to 4208 °C 0 to 2320	0 to 39.506	17.0	

*Not ANSI Symbol.

Temperature Dependent Data

MAXIMUM* LONG-TERM SERVICE TEMPERATURE FOR OMEGACLAD™

OMEGACLAD™ is a 3 part system composed of compacted ceramic insulation, thermocouple wire and metal sheath. Therefore, three factors determine the useful service temperature for OMEGACLAD™.

- Range for the thermocouple wire (see table—limits of error)
- Maximum service temperature of insulation. In the case of MgO, this is in excess of 3000°F (1650°C)
- Properties of the sheath material:

Thermocouple Type	Nominal Diameter	Sheath Material	
		Stainless Steel	Inconel
T	¼″	700°F (370°C)	700°F (370°C)
J	¼″	1400°F (770°C)	1400°F (770°C)
E	¼″	1650°F (900°C)	1650°F (900°C)
K	¼″	1650°F (900°C)	2100°F (1150°C)

*Based on limitations imposed by sheath or thermocouple wire, whichever is lower

Material	Melting Point	Continuous Max. Temp.	Tensile (PSI) Strength	
			at 200°F	at 1000°F
304 S.S.	2560°F	1650°F	68,000	15,000
316 S.S.	2500°F	1650°F	75,000	23,000
Inconel*	2550°F	2100°F	93,000	5,000

*Vacuum or Inert atmosphere only.

MAXIMUM LONG-TERM SERVICE TEMPERATURE FOR PROTECTED BARE WIRE THERMOCOUPLES OF VARIOUS WIRE DIAMETERS.

symbol	Alloy Combination	0.005″	0.015″	0.020″	0.032″
T	Copper-Constantan	400°F	400°F	400°F	500°F
J	Iron-Constantan	600°F	700°F	700°F	900°F
E	Chromel-Constantan	700°F	800°F	800°F	1000°F
K	Chromel-Alumel	1100°F	1600°F	1600°F	1800°F
R,S	Platinum-Rhodium			2700°F	
B	Platinum-Rhodium			3100°F	
C, G, D†	Tungsten-Rhenium*	3600°F	4200°F	4200°F	

†Not ANSI Symbols

Trade Names: Cupron Nial and Tophel-AMAX. / Advance, T1 and T2-Driver-Harris Co. / Chromel and Alumel-Hoskins Mfg. Co./Thermokanthal KP and Thermokanthal KN-Kanthal Co.

NOTE: The table above is only meant as a guide. Wire may be used to higher temperatures within overall range with subsequent decrease in lifetime. (ie: type K wire serviceable to 2300°F).

Table C

Melting Temperatures of Some Important Metals

Approximate melting points are given only as a guide for material selection since many factors including atmosphere, type of process, mounting, etc., all affect the operating maximum.

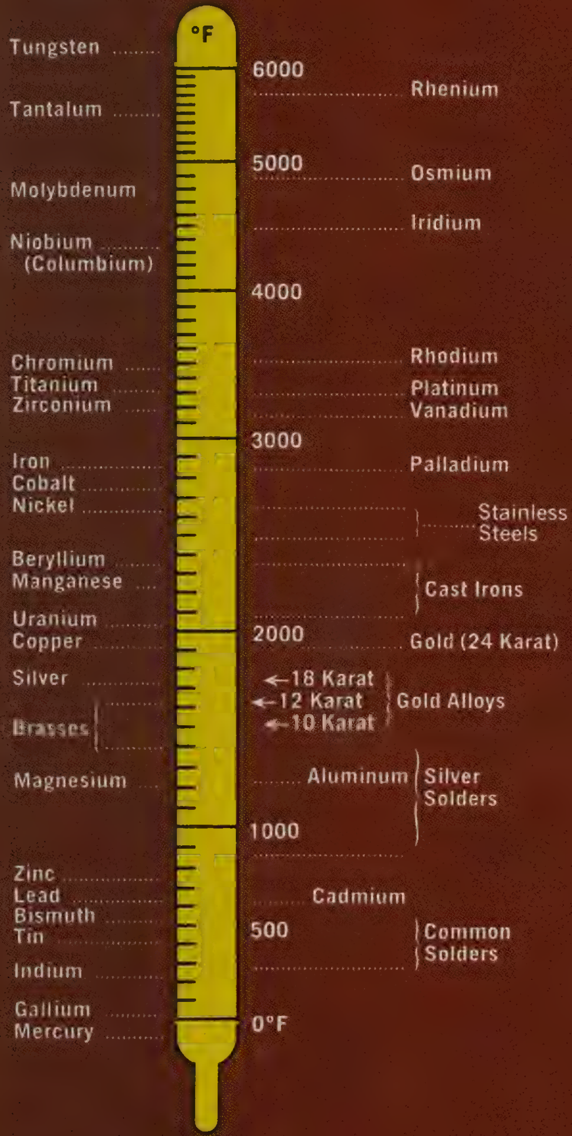


Table D

Very High Temperature Sheath Materials

Sheath Material	Rec. Useful Temp.	Melting Point	Environmental Conditions			
			Oxidizing	Hydrogen	Inert	Vacuum
Molybdenum	4000°F	4730°F	Not Rec.	Fair	Fair	Good
Tantalum	4500°F	5425°F	Not Rec.	Not Rec.	Not Rec.	Good
Platinum	3050°F	3223°F	Very Good	Poor	Poor	Poor

Table E

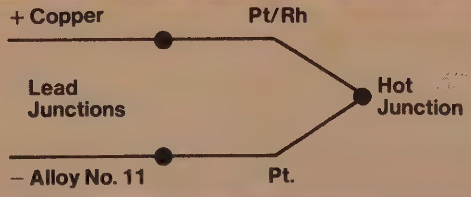
Thermometry Fixed Points

THERMOELECTRIC FIXED POINT	MELTING POINTS FROM THE PRACTICAL INTERNATIONAL TEMPERATURE SCALE IPTS-68	
	°C	°F
Boiling point of oxygen	−183.0	−297.3
Sublimation point of carbon dioxide	− 78.5	−109.2
Freezing point of mercury	− 38.9	− 38
Ice Point	0	32
Triple point of water	0.01	32
Boiling point of water	100.0	212
Triple point of benzoic acid	122.4	252.3
Boiling point of naphthalene	218	424.4
Freezing point of tin	231.9	449.4
Boiling point of benzophenone	305.9	582.6
Freezing point of cadmium	321.1	610
Freezing point of lead	327.5	621.5
Freezing point of zinc	419.6	787.2
Boiling point of sulfur	444.7	832.4
Freezing point of antimony	630.7	1167.3
Freezing point of aluminum	660.4	1220.7
Freezing point of silver	961.9	1763.5
Freezing point of gold	1064.4	1948
Freezing point of copper	1084.5	1984.1
Freezing point of palladium	1554	2829
Freezing point of platinum	1772	3222

Table F

Extension Grade Wires for Platinum and Tungsten-Rhenium Alloys

Compensating alloys made into extension wire for tungsten-rhenium thermocouples and platinum-rhodium thermocouples closely match the **emf** of the thermocouples over limited range.



- The alloy 405/426 combination is used with Tungsten 5% Re vs Tungsten 26% Re.
- The alloy 200/226 combination is used with Tungsten vs Tungsten 26% Re.
- The alloy 203/225 combination is used with Tungsten 3% Re vs Tungsten 25% Re.
- The combination copper/alloy #11 is used with platinum-rhodium alloys vs pure platinum.

Table G
Thermoelectric Alloy Property Data

ALLOY or DESIGNATION	Notes	Percent Purity or Composition	RESISTIVITY (ohm/cmf) (at 0°C)		TEMP. COEFF. OF RESISTANCE (0 – 100°C)		TENSILE STRENGTH (psi × 1000)		ELONGATION (percent)		Melting Point °C	Density (g/cm³)
			Hard	Annld	Hard	Annld	Hard	Annld	Hard	Annld		
Pure Metals												
Iron		99.9+%	66	60	.0062	.0065	90	34	2	40	1536	7.9
Nickel		99.98%	39	37	.0064	.0068	100	48	2	36	1452	8.9
Molybdenum		99.9+%	42	31	.0036	0047	250	120	2	16	2610	10.2
Aluminum (H-P)		99.99+%	17.4	15	.0038	.0044	16.3	6.8	5	60	660	2.71
Copper		99.98%	9.44	9.24	.0041	.0043	76	32	1.5	46	1083	8.93
Gold		99.999%	13.4	13.17	.0039	.0040	46	19	1.5	36	1063	19.30
Silver		99.99%	9.3	8.83	.0038	.0041	52	24	1.5	46	960.8	10.5
Tungsten		99.99%	42	33	.0036	.0048	285	80	—	3	3410	19.3
Rhenium		99.99%	—	117	—	—	360	170	—	10	3170	20.0
Platinum-Ref.		99.999+%	61.2	59.13	.00386	.00393	60	24	2	38	1769	21.45
Rhodium		99.99%	33.0	25.8	.0029	.0046	275	120	2	16	1966	12.42
Platinum Alloys												
Pt– 6% Rh		94% Pt– 6% Rh	101	95	.0019	.0020	85	37	1.5	34	1810	20.51
Pt–10% Rh		90% Pt–10% Rh	114	111	.0016	.0017	95	46	1.5	32	1830	19.95
Pt–13% Rh		87% Pt–13% Rh	119	114	.0015	.0016	105	48	1.5	32	1840	19.55
Pt–20% Rh		80% Pt–20% Rh	124	116	.0013	.0014	140	72	1.5	32	1870	18.65
Pt–30% Rh		70% Pt–30% Rh	116	112	.0013	.0014	160	74	1.5	26	1910	17.52
Pt–40% Rh		60% Pt–40% Rh	108	101	.0013	.0014	190	78	1.5	26	1920	16.54
Nickel Alloys												
Constantan		55% Cu–45% Ni	315	294	±.00003	±.00002	150	80	2	32	1270	8.86
Chromel–P	(1)	90% Ni–10% Cr	—	425	.00032	.00032	165	95	2	27	1430	8.73
Alumel	(1)	95% Ni–2% Mn–2% AL	—	177	.00188	.00188	170	85	2	32	1400	8.60
Tungsten Alloys												
Tungsten 3% Re		97% W– 3% Re	—	55	—	—	320	180	—	10	3410	19.4
Tungsten 5% Re		95% W– 5% Re	—	70	—	—	320	200	—	10	3350	19.4
Tungsten 25% Re		75% W–25% Re	—	165	—	—	300	210	—	10	3130	19.7
Tungsten 26% Re		74% W–26% Re	—	170	—	—	300	200	—	10	3120	19.7
Compensating Alloys												
Alloy #11	(2)	Pt alloys	—	30	—	.0014	105	50	2	30	1090	8.91
Alloy #200	(2)	Tungsten	—	470	—	—	—	—	—	—	1430	8.73
Alloy #203	(2)	Tungsten– 3% Re	—	470	—	.0003	—	—	—	—	1400	8.60
Alloy #205	(2)	Tungsten– 5% Re	—	510	—	—	—	—	—	—	1410	8.58
Alloy #225	(2)	Tungsten–25% Re	—	180	—	.0012	—	—	—	—	1370	8.88
Alloy #226	(2)	Tungsten–26% Re	—	160	—	—	—	—	—	—	1450	8.85
Alloy #260	(2)	Tungsten–26% Re	—	750	—	—	—	—	—	—	1520	7.42

1 Trade name Hoskins Mfg. Co.
2 See notes on extension wires for platinum and tungsten alloys. Percent purity or composition column refers to matching alloy.

Table H
Limits of Error Thermocouples† Reference Junction 0°C

LIMITS OF ERROR FOR THERMOCOUPLES[1]: REFERENCE JUNCTION 0°C

Thermo-couple Type	Temperature Range °C	Temperature Range °F	Limits of Error[2]	
			Standard (Whichever is greater)	Special (Whichever is greater)
T	0 to 350	32 to 662	±1.0°C or ±0.75%	±0.5°C or .4%
J	0 to 750	32 to 1382	±2.2°C or ±0.75%	±1.1°C or .4%
E	0 to 900	32 to 1652	±1.7°C or ±0.5%	±1.0°C or .4%
K	0 to 1250	32 to 2282	±2.2°C or ±0.75%	±1.1°C or .4%
R or S	0 to 1450	32 to 2642	±1.5°C or ±0.25%	±0.6°C or .1%
B	800 to 1700	1472 to 3092	±0.5%	Not Estab.
C*, G*, D*	0 to 425	32 to 797	±4.5°C	Not Estab.
	425 to 2320	797 to 4208	±1.0%	Not Estab.
	Sub-Zero Range[3]			
T	–200 to 0	–328 to 32	±1.0°C or ±1.5%	Not Estab.
E	–200 to 0	–328 to 32	±1.7°C or ±1.0%	Not Estab.
K	–200 to 0	–328 to 32	±2.2°C or ±2.0%	Not Estab.

[1] ANSI MC 96.1 (1975)
These limits are given only as a guide for discussion between purcharser and supplier.

[2] The limits of error of the thermocouples and extension wires are based on a Reference Junction temperature of 32°F (0°C). Does not include use or installation errors.

[3] Due to the characteristics of the materials, sub-zero limits of error for type J thermocouples are not listed.

[4] Due to the non-linearity of the noble metal temperature-emf curves, the error introduced into a thermocouple system by the compensating wire will be variable when expressed in degrees. The °F and °C limits of error are based on the following measuring junction temperatures:

Type Wire	Measuring Junction Temperature
SX, RX	Greater than 1598°F (870°C)
BX	Greater than 1832°F (1000°C)

[5] Copper versus copper compensating extension wire is usable to 212°F (100°C) with deviation errors as indicated over the full range. No significant error is observed over the 32 to 122°F (0 to 50°C) portion of the range.

*Not ANSI symbol

Thermocouple Types

Iron-Constantan (ANSI Symbol J) The Iron-Constantan "J" curve thermocouple with a positive iron wire and a negative Constantan wire is recommended for reducing atmospheres. The operating range for this alloy combination is 1600°F for the largest wire sizes. Smaller size wires should operate in correspondingly lower temperatures.

Copper-Constantan (ANSI Symbol T) The Copper-Constantan "T" curve thermocouple, with a positive copper wire and a negative Constantan wire is recommended for use in mildly oxidizing and reducing atmospheres up to 750°F. They are suitable for applications where moisture is present. This alloy is recommended for low temperature work since the homogeneity of the component wires can be maintained better than other base metal wires. Therefore, errors due to inhomogeneity of wires in zones of temperature gradients is greatly reduced.

Chromel-Alumel* (ANSI Symbol K) The Chromel-Alumel "K" curve thermocouple with a positive Chromel wire and a negative Alumel wire is recommended for use in clean oxidizing atmospheres. The operating range for this alloy is 2300°F for the largest wire sizes. Smaller wires should operate in correspondingly lower temperatures.

Chromel-Constantan (ANSI Symbol E) The Chromel-Constantan thermocouple may be used for temperatures up to 1600°F in a vacuum or inert, mildly oxidizing or reducing atmosphere. At sub-zero temperatures, the thermocouple is not subject to corrosion. This thermocouple has the highest emf output of any standard metallic thermocouple.

Platinum-Rhodium Alloys (ANSI Symbol S, R and B) Three types of "noble-metal" thermocouples are in common use; they are: 1) a positive wire of 90% platinum and 10% rhodium used with a negative wire of pure platinum, 2) a positive wire of 87% platinum and 13% rhodium used with a negative wire of pure platinum, and 3) a positive wire of 70% platinum and 30% rhodium used with a negative wire of 94% platinum and 6% rhodium. They have a high resistance to oxidation and corrosion. However, hydrogen, carbon and many metal vapors can contaminate a platinum-rhodium thermocouple. The recommended operating range for the platinum-rhodium alloys is 2800°F although temperatures as high as 3270°F can be measured with the Pt-30% Rh vs Pt-6% Rh alloy combination.

Tungsten-Rhenium Alloys Three types of tungsten-rhenium thermocouples are in common use for measuring temperatures up to 5000°F. These alloys have inherently poor oxidation resistance and should be used in vacuum, hydrogen or inert atmospheres.

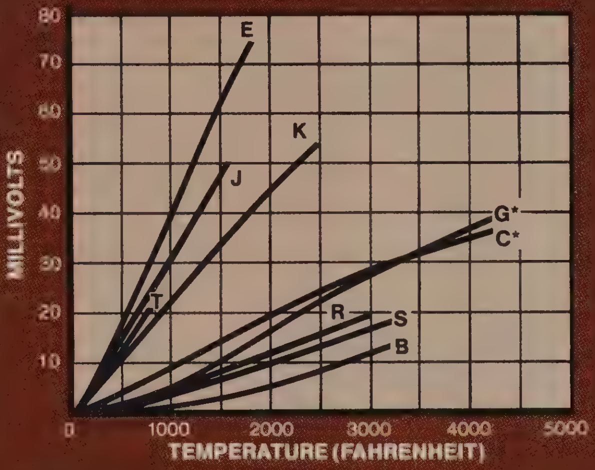
*Equivalent material now available from other manufacturers. See "Trade Names of Alloys" table above.

Trade Names of Alloys

ANSI DESIGNATION	ALLOY (Generic or Trade Names)
JP	Iron
JN, EN, or TN	Constantan, Cupron, Advance
KP or EP	Chromel, Tophel, T_1, Thermokanthal KP
KN	Alumel, Nial, T_2, Thermokanthal KN
TP	Copper
RN or SN	Pure Platinum
RP	Platinum 13% Rhodium
SP	Platinum 10% Rhodium

Trade Names: Advance T — Driver-Harris Co.; Chromel and Alumel — Hoskins Mfg. Co.; Cupron, Nial and Tophel — Wilbur B. Driver Co.; Thermokanthal KP and Thermokanthal KN — The Kanthal Corporation.

ANSI LETTER DESIGNATIONS — Currently thermocouple and extension wire is ordered and specified by an ANSI letter designation. Popular generic and trade name examples are Chromel/Alumel — ANSI Type K; Iron/Constantan — ANSI Type J; Copper/Constantan — ANSI Type T; Chromel/Constantan — ANSI Type E; Platinum/Platinum 10% Rhodium — ANSI Type S; Platinum/Platinum 13% Rhodium — ANSI Type R. The positive and negative legs are identified by letter suffixes P and N respectively, as listed in the tables.



ANSI Symbol

T	Copper vs. Constantan
E	Chromel vs. Constantan
J	Iron vs. Constantan
K	Chromel vs. Alumel
G*	Tungsten vs. Tungsten 26% Rhenium
C*	Tungsten 5% Rhenium vs. Tungsten 26% Rhenium
D*	Tungsten 3% Rhenium vs. Tungsten 25% Rhenium
R	Platinum 13% Rhodium vs. Platinum
S	Platinum 10% Rhodium vs. Platinum
B	Platinum 30% Rhodium vs. Platinum 6% Rhodium

*Not ANSI Symbol

Table K

Thermocouple Wire Size and Resistance Table

Resistance in Ohms per Double Foot at 68°F.

AWG No.	Diameter (inches)	Type K Chromel/ Alumel	Type J Iron/ Constantan	Type T Copper/ Constantan	Type E Chromel/ Constantan	Type S Pt/ Pt10% Rh	Type R Pt/ Pt13% Rh	Type C* W5% Re/ W26% Re	Type G* W/ W26% Re	Type D* W3% Re/ W25% Re
6	0.162	0.023	0.014	0.012	0.027	0.007	0.007	0.009	0.008	0.009
8	0.128	0.037	0.022	0.019	0.044	0.011	0.011	0.015	0.012	0.015
10	0.102	0.058	0.034	0.029	0.069	0.018	0.018	0.023	0.020	0.022
12	0.081	0.091	0.054	0.046	0.109	0.028	0.029	0.037	0.031	0.035
14	0.064	0.146	0.087	0.074	0.175	0.045	0.047	0.058	0.049	0.055
16	0.051	0.230	0.137	0.117	0.276	0.071	0.073	0.092	0.078	0.088
18	0.040	0.374	0.222	0.190	0.448	0.116	0.119	0.148	0.126	0.138
20	0.032	0.586	0.357	0.298	0.707	0.185	0.190	0.235	0.200	0.220
24	0.0201	1.490	0.878	0.7526	1.78	0.464	0.478	0.594	0.560	0.560
26	0.0159	2.381	1.405	1.204	2.836	0.740	0.760	0.945	0.803	0.890
30	0.0100	5.984	3.551	3.043	7.169	1.85	1.91	2.38	2.03	2.26
32	0.0080	9.524	5.599	4.758	11.31	1.96	3.04	3.8	3.22	3.60
34	0.0063	15.17	8.946	7.66	18.09	4.66	4.82	6.04	5.10	5.70
36	0.0050	24.08	14.20	12.17	28.76	7.40	7.64	9.6	8.16	9.10
38	0.0039	38.20	23.35	19.99	45.41	11.6	11.95	15.3	12.9	15.3
40	0.00315	60.88	37.01	31.64	73.57	18.6	19.3	24.4	20.6	23.0
44	0.0020	149.6	88.78	76.09	179.2	74.0	76.5	60.2	51.1	56.9
50	0.0010	598.4	355.1	304.3	716.9	185	191	240	204	227
56	0.00049	2408	1420	1217	2876	740	764	1000	850	945

*Not ANSI Symbol.

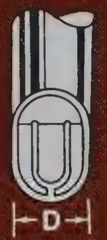
Comparison of Time Constant* vs Overall Outside Diameter of Bare Thermocouple Wires or Grounded Junction Thermocouples

Time constants calculated for air at room temperature and atmospheric pressure moving with velocity of 65 feet per second for thermocouples shown in Figures #1 and #2.

For beaded-type and ungrounded junctions (Figures #3 or #4) multiply time constants by 1.5.

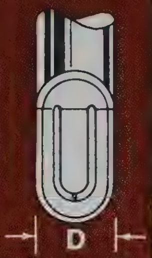
Time constant of thermocouple made with exposed butt welded 0.001 inch dia. wire = .003 sec.

BARE WIRE
Butt Welded
Fig. #1



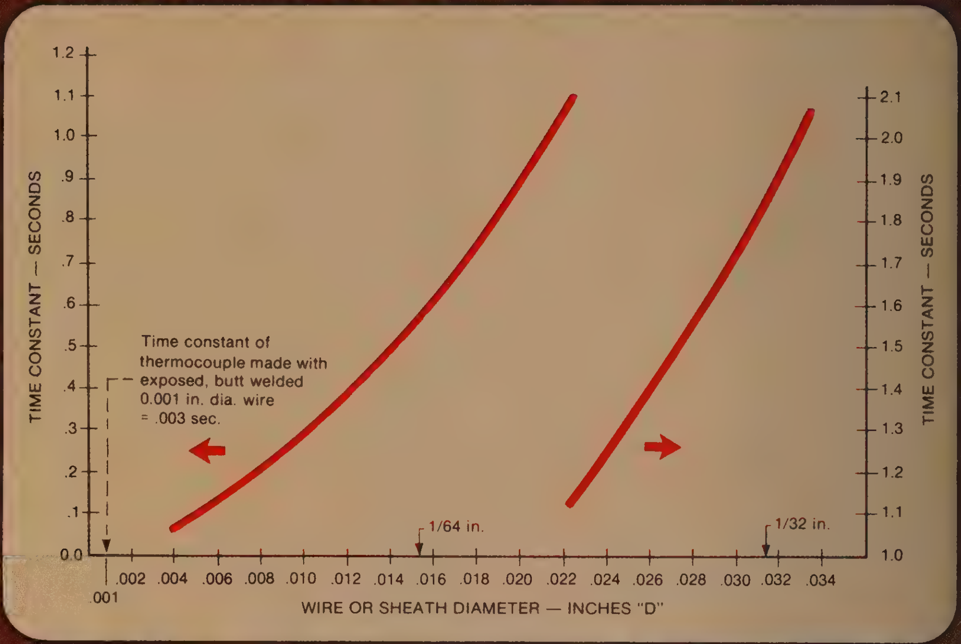
GROUNDED
Junction
Fig. #2

BEADED-TYPE
Thermocouple
Fig. #3



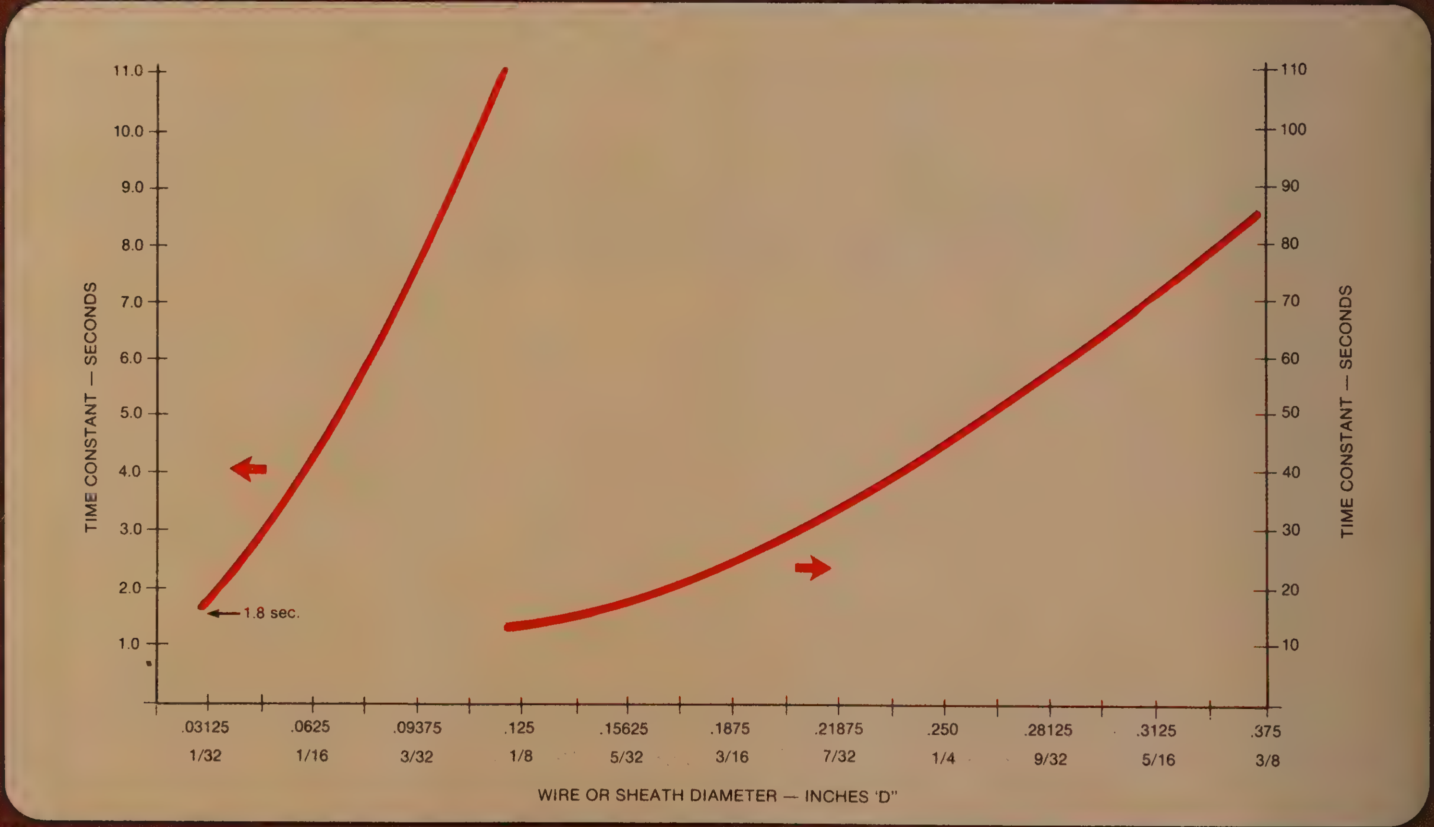
UNGROUNDED-
TYPE
Thermocouple
Fig. #4

Figure L **Sheath Diameter .004″ to .034″**



Because of space limitations, time constant curve is divided into 4 separate curves.

Figure M **Sheath Diameter 1/32″ to 3/8″**



Note:

These comparisons apply to either bare "butt-welded" or "grounded" junction thermocouples. If the thermocouples are the "beaded-type" or "ungrounded" the time constant is longer. These times are only approximate and are for comparison purposes only. Multiply values from Time Constants by 1.5 for junctions shown in Fig. #3 and Fig. #4

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*The "Time Constant" or "Response Time" is defined as the time required to reach 63.2% of an instantaneous temperature change.

Material Selection Guide

This chart is a guide in the selection of thermocouple sheath and thermowell materials according to the process fluid. It includes factors such as catalytic reaction, contamination and electrolysis. However, there are many instances where factors other than these must be considered. It is recommended that such special applications be submitted to OMEGA ENGINEERING for recommendations.

These recommendations are only guides based on the most economical material selection. OMEGA ENGINEERING cannot be held responsible if these recommendations are not satisfactory for specific applications.

SUBSTANCE	CONDITIONS	RECOMMENDED METAL
Acetate Solvents	Crude or Pure	Monel or Nickel
Acetic Acid	10% - 70°F	304 Stainless Steel
" "	50% - 70°F	304 Stainless Steel
" "	50% - 212°F	316 Stainless Steel
" "	99% - 70°F	430 Stainless Steel
" "	99% - 212°F	430 Stainless Steel
Acetic Anhydride		Monel
Acetone	212°F	304 Stainless Steel
Acetylene		304. Monel. Nickel
Alcohol Ethyl	70°F	304 Stainless Steel
" "	212°F	304 Stainless Steel
Alcohol Methyl	70°F	304 Stainless Steel
" "	212°F	304 Stainless Steel
Aluminum	Molten	Cast Iron
Aluminum Acetate	Saturated	304 Stainless Steel
Aluminum Sulphate	10% - 70°F	304 Stainless Steel
" "	Saturated 70°F	304 Stainless Steel
" "	10% - 212°F	316 Stainless Steel
" "	Saturated 212°F	316 Stainless Steel
Ammonia	All concentrations 70°F	304 Stainless Steel
Ammonium Chloride	All concentrations 212°F	316 Stainless Steel
Ammonium Nitrate	All concentrations 70°F	304 Stainless Steel
" "	All concentrations 212°F	304 Stainless Steel
Ammonium Sulphate	5% - 70°F	304 Stainless Steel
" "	10% - 212°F	316 Stainless Steel
" "	Saturated 212°F	316 Stainless Steel
Aniline	All concentrations 70°F	304 Stainless Steel
Amylacetate		Monel
Asphalt		Steel (C1018) Phosphor Bronze. Monel. Nickel
Barium Carbonate	70°F	304 Stainless Steel
Barium Chloride	5% - 70°F	Monel
" "	Saturated 70°F	Monel
" "	Aqueous - Hot	316 Stainless Steel
Barium Hydroxide		Steel (C1018)
Barium Sulphite		Nichrome
Benzaldehyde		Steel (C1018)
Benzene	70°F	304 Stainless Steel
Benzine		Steel (C1018) Monel. Inconel
Benzol	Hot	304 Stainless Steel
Boracic Acid	5% Hot or Cold	304 Stainless Steel
Bromine	70°F	Tantalum
Butadiene		Brass. 304
Butane	70°F	304 Stainless Steel
Butylacetate		Monel
Butyl Alcohol		Copper
Butylenes		Steel (C1018). Phosphor Bronze
Butyric Acid	5% - 70°F	304 Stainless Steel
" "	5% - 150°F	304 Stainless Steel
Calcium Bisulfite	70°F	316 Stainless Steel
Calcium Chlorate	Dilute 70°F	304 Stainless Steel
" "	Dilute 150°F	304 Stainless Steel
Calcium Hydroxide	10% - 212°F	304 Stainless Steel
" "	20% - 212°F	304 Stainless Steel
" "	50% - 212°F	317 Stainless Steel
Carbolic Acid	All 212°F	316 Stainless Steel
Carbon Dioxide	Dry	Steel (C1018). Monel
Carbon Dioxide	Wet	Aluminum.Monel.Nickel
Carbon Tetrachloride	10% - 70°F	Monel
Chlorex Caustic		316SS. 317SS
Chlorine Gas	Dry 70°F	317 Stainless Steel
" "	Moist 70°F	Hastelloy C
" "	Moist 212°F	Hastelloy C
Chromic Acid	5% - 70°F	304 Stainless Steel
" "	10% - 212°F	316 Stainless Steel
" "	50% - 212°F	316 Stainless Steel
Citric Acid	15% - 70°F	304 Stainless Steel
" "	15% - 212°F	316 Stainless Steel
" "	Concentrated 212°F	317 Stainless Steel
Coal Tar	Hot	304 Stainless Steel
Coke Oven Gas		Aluminum
Copper Nitrate		304. 316
Copper Sulphate		304. 316
Core Oils		316 Stainless Steel
Cottonseed Oil		Steel (C1018). Monel. Nickel
Creosols		304 Stainless Steel
Creosote Crude		Steel (C1018). Monel Nickel
Cyanogen Gas		304 Stainless Steel
Dowtherm		Steel (C1018)
Epsom Salt	Hot and Cold	304 Stainless Steel
Ether	70°F	304 Stainless Steel
Ethyl Acetate		Monel
Ethyl Chloride	70°F	304 Stainless Steel
Ethylene Glycol		Steel (C1018)
Ethyl Sulphate	70°F	Monel
Ferric Chloride	1% - 70°F	316 Stainless Steel
" "	5% - 70°F	Tantalum
" "	5% - Boiling	Tantalum
Ferric Sulphate	5% - 70°F	304 Stainless Steel
Ferrous Sulphate	Dilute 70°F	304 Stainless Steel
Formaldehyde		304 Stainless Steel
Freon		Steel (C1018)
Formic Acid	5% - 70°F	316 Stainless Steel
" "	5% - 150°F	316 Stainless Steel
Gallic Acid	5% - 70°F	Monel
" "	5% - 150°F	Monel
Gasoline	70°F	304 Stainless Steel
Glucose	70°F	304 Stainless Steel
Glycerine	70°F	304 Stainless Steel
Glycerol		304 Stainless Steel
Heat Treating		446 Stainless Steel
Hydrobromic Acid	48% - 212°F	Hastelloy B
Hydrochloric Acid	1% - 70°F	Hastelloy C
" "	1% - 212°F	Hastelloy B
" "	5% - 70°F	Hastelloy C
" "	5% - 212°F	Hastelloy B
" "	25% - 70°F	Hastelloy B
" "	25% - 212°F	Hastelloy B
Hydrocyanic Acid		316 Stainless Steel
Hydrofluoric Acid		Hastelloy C
Hydrogen Peroxide	70°F	316 Stainless Steel
" "	212°F	316 Stainless Steel
Hydrogen Sulphide	Wet and dry	316 Stainless Steel
Iodine	70°F	Tantalum
Kerosene	70°F	304 Stainless Steel
Lactic Acid	5% - 70°F	304 Stainless Steel
" "	5% - 150°F	316 Stainless Steel
" "	10% - 212°F	Tantalum
Lacquer	70°F	316 Stainless Steel
Latex		Steel (C1018)
Lime Sulphur		Steel (C1018). 304. Monel
Linseed Oil	70°F	304 Stainless Steel
Magnesium Chloride	5% - 70°F	Monel
" "	5% - 212°F	Nickel
Magnesium Sulphate	Cold and Hot	Monel
Malic Acid	Cold and Hot	316 Stainless Steel
Mercury		Steel (C1018). 304. Monel
Methane	70°F	Steel (1020)
Milk		304. Nickel
Mixed Acids (Sulphuric and Nitric — all temp. and %)		Carpenter #20
Molasses		Steel (C1018). 304. Monel. Nickel
Muriatic Acid	70°F	Tantalum
Naphtha	70°F	304 Stainless Steel
Natural Gas	70°F	304 Stainless Steel
Neon	70°F	304 Stainless Steel
Nickel Chloride	70°F	304 Stainless Steel
Nickel Sulphate	Hot and Cold	304 Stainless Steel
Nitric Acid	5% - 70°F	304 Stainless Steel
" "	20% - 70°F	304 Stainless Steel
" "	50% - 70°F	304 Stainless Steel
" "	50% - 212°F	304 Stainless Steel
" "	65% - 212°F	316 Stainless Steel
" "	Concentrated - 70°F	304 Stainless Steel
" "	Concentrated - 212°F	Tantalum
Nitrobenzene	70°F	304 Stainless Steel
Nitrous Acid		304 Stainless Steel
Oleic Acid	70°F	316 Stainless Steel
Oleum	70°F	316 Stainless Steel
Oxalic Acid	5% - Hot and Cold	304 Stainless Steel
" "	10% - 212°F	Monel
Oxygen	70°F	Steel (C1018)
Oxygen	Liquid	304 Stainless Steel
Palmitic Acid		316 Stainless Steel
Petroleum Ether		304 Stainless Steel
Phenol		304 Stainless Steel
Pentane		304 Stainless Steel
Phosphoric Acid	1% - 70°F	304 Stainless Steel
" "	5% - 70°F	304 Stainless Steel
" "	10% - 70°F	316 Stainless Steel
" "	10% - 212°F	Hastelloy C
" "	30% - 70°F	Hastelloy B
" "	30% - 212°F	Hastelloy B
" "	85% - 70°F	Hastelloy B
" "	85% - 212°F	Hastelloy B
Picric Acid	70°F	304 Stainless Steel
Potassium Bromide	70°F	316 Stainless Steel
Potassium Carbonate	1% - 70°F	304 Stainless Steel
Potassium Chlorate	70°F	304 Stainless Steel
Potassium Chloride	5% - 70°F	304 Stainless Steel
" "	5% - 212°F	304 Stainless Steel
Potassium Hydroxide	5% - 70°F	304 Stainless Steel
" "	25% - 212°F	304 Stainless Steel
" "	50% - 212°F	316 Stainless Steel
Potassium Nitrate	5% - 70°F	304 Stainless Steel
" "	5% - 212°F	304 Stainless Steel
Potassium Permanganate	5% - 70°F	304 Stainless Steel
Potassium Sulphate	5% - 70°F	304 Stainless Steel
" "	5% - 212°F	304 Stainless Steel
Potassium Sulphide	70°F	304 Stainless Steel
Propane		304 Stainless Steel
Pyrogallic Acid		304 Stainless Steel
Quinine Bisulphate	Dry	316 Stainless Steel
Quinine Sulphate	Dry	304 Stainless Steel
Resin		304 Stainless Steel
Rosin	Molten	304 Stainless Steel
Sea Water		Monel
Salommoniac		Monel
Salicylic Acid		Nickel
Shellac		304 Stainless Steel
Soap	70°F	304 Stainless Steel
Sodium Bicarbonate	All concentrations 70°F	304 Stainless Steel
" "	5% - 150°F	304 Stainless Steel
Sodium Bisulphate		Monel
Sodium Carbonate	5% - 70°F	304 Stainless Steel
" "	5% - 150°F	304 Stainless Steel
Sodium Chloride	5% - 70°F	316 Stainless Steel
Sodium Chloride	5% - 150°F	316 Stainless Steel
" "	Saturated - 70°F	316 Stainless Steel
" "	Saturated - 212°F	316 Stainless Steel
Sodium Fluoride	5% - 70°F	Monel
Sodium Hydroxide		304 Stainless Steel
Sodium Hypochlorite	5% still	316 Stainless Steel
Sodium Nitrate	Fused	317 Stainless Steel
Sodium Peroxide		304 Stainless Steel
Sodium Phosphate		Steel (C1018)
Sodium Silicate		Steel (C1018)
Sodium Sulphate	70°F	304 Stainless Steel
Sodium Sulphide	70°F	316 Stainless Steel
Sodium Sulphite	150°F	304 Stainless Steel
Steam		304 Stainless Steel
Stearic Acid		304 Stainless Steel
Sulphur Dioxide	Moist Gas - 70°F	316 Stainless Steel
" "	Gas - 575°F	304 Stainless Steel
Sulphur	Dry - Molten	304 Stainless Steel
"	Wet	316 Stainless Steel
Sulphuric Acid	5% - 70°F	Carp. 20. Hastelloy B
" "	5% - 212°F	Carp. 20. Hastelloy B
" "	10% - 70°F	Carp. 20. Hastelloy B
" "	10% - 212°F	Carp. 20. Hastelloy B
" "	50% - 70°F	Carp. 20. Hastelloy B
" "	50% - 212°F	Carp. 20. Hastelloy B
" "	90% - 70°F	Carp. 20. Hastelloy B
" "	90% - 212°F	Hastelloy D
Tannic Acid	70°F	304 Stainless Steel
Tar		Steel (C1018). 304. Monel. Nickel
Tartaric Acid	70°F	304 Stainless Steel
" "	150°F	316 Stainless Steel
Tin	Molten	Cast Iron
Tolvene		Aluminum. Phosphor Bronze. Monel
Trichloroethylene		Steel (C1018)
Turpentine		304 Stainless Steel
Varnish		304 Stainless Steel
Vegetable Oils		Steel (C1018). 304. Monel
Vinegar		304 Stainless Steel
Water	Fresh	Copper. Steel (C1018). Monel
Water	Salt	Aluminum.Brass.Monel
Whiskey. Wine		304. Nickel
Xylene		Copper
Zinc	Molten	Cast Iron
Zinc Chloride		Monel
Zinc Sulphate	5% - 70°F	304 Stainless Steel
" "	Saturated - 70°F	304 Stainless Steel
" "	25% - 212°F	304 Stainless Steel

TABLE I

TYPE J

New Reference Tables
Supersedes N.B.S.
Circular #561

Iron Vs. Copper-Nickel

(Iron-Constantan)

Temperature in Degrees C
Reference Junction at 0°C

THERMOELECTRIC VOLTAGE IN ABSOLUTE MILLIVOLTS

DEG C	0	1	2	3	4	5	6	7	8	9	10	DEG C
-210	-8.096											-210
-200	-7.890	-7.912	-7.934	-7.955	-7.976	-7.996	-8.017	-8.037	-8.057	-8.076	-8.096	-200
-190	-7.659	-7.683	-7.707	-7.731	-7.755	-7.778	-7.801	-7.824	-7.846	-7.868	-7.890	-190
-180	-7.402	-7.429	-7.455	-7.482	-7.508	-7.533	-7.559	-7.584	-7.609	-7.634	-7.659	-180
-170	-7.122	-7.151	-7.180	-7.209	-7.237	-7.265	-7.293	-7.321	-7.348	-7.375	-7.402	-170
-160	-6.821	-6.852	-6.883	-6.914	-6.944	-6.974	-7.004	-7.034	-7.064	-7.093	-7.122	-160
-150	-6.499	-6.532	-6.565	-6.598	-6.630	-6.663	-6.695	-6.727	-6.758	-6.790	-6.821	-150
-140	-6.159	-6.194	-6.228	-6.263	-6.297	-6.331	-6.365	-6.399	-6.433	-6.466	-6.499	-140
-130	-5.801	-5.837	-5.874	-5.910	-5.946	-5.982	-6.018	-6.053	-6.089	-6.124	-6.159	-130
-120	-5.426	-5.464	-5.502	-5.540	-5.578	-5.615	-5.653	-5.690	-5.727	-5.764	-5.801	-120
-110	-5.036	-5.076	-5.115	-5.155	-5.194	-5.233	-5.272	-5.311	-5.349	-5.388	-5.426	-110
-100	-4.632	-4.673	-4.714	-4.755	-4.795	-4.836	-4.876	-4.916	-4.956	-4.996	-5.036	-100
-90	-4.215	-4.257	-4.299	-4.341	-4.383	-4.425	-4.467	-4.508	-4.550	-4.591	-4.632	-90
-80	-3.785	-3.829	-3.872	-3.915	-3.958	-4.001	-4.044	-4.087	-4.130	-4.172	-4.215	-80
-70	-3.344	-3.389	-3.433	-3.478	-3.522	-3.566	-3.610	-3.654	-3.698	-3.742	-3.785	-70
-60	-2.892	-2.938	-2.984	-3.029	-3.074	-3.120	-3.165	-3.210	-3.255	-3.299	-3.344	-60
-50	-2.431	-2.478	-2.524	-2.570	-2.617	-2.663	-2.709	-2.755	-2.801	-2.847	-2.892	-50
-40	-1.960	-2.008	-2.055	-2.102	-2.150	-2.197	-2.244	-2.291	-2.338	-2.384	-2.431	-40
-30	-1.481	-1.530	-1.578	-1.626	-1.674	-1.722	-1.770	-1.818	-1.865	-1.913	-1.960	-30
-20	-0.995	-1.044	-1.093	-1.141	-1.190	-1.239	-1.288	-1.336	-1.385	-1.433	-1.481	-20
-10	-0.501	-0.550	-0.600	-0.650	-0.699	-0.748	-0.798	-0.847	-0.896	-0.945	-0.995	-10
0	0.000	-0.050	-0.101	-0.151	-0.201	-0.251	-0.301	-0.351	-0.401	-0.451	-0.501	0
DEG C	0	1	2	3	4	5	6	7	8	9	10	DEG C
0	0.000	0.050	0.101	0.151	0.202	0.253	0.303	0.354	0.405	0.456	0.507	0
10	0.507	0.558	0.609	0.660	0.711	0.762	0.813	0.865	0.916	0.967	1.019	10
20	1.019	1.070	1.122	1.174	1.225	1.277	1.329	1.381	1.432	1.484	1.536	20
30	1.536	1.588	1.640	1.693	1.745	1.797	1.849	1.901	1.954	2.006	2.058	30
40	2.058	2.111	2.163	2.216	2.268	2.321	2.374	2.426	2.479	2.532	2.585	40
50	2.585	2.638	2.691	2.743	2.796	2.849	2.902	2.956	3.009	3.062	3.115	50
60	3.115	3.168	3.221	3.275	3.328	3.381	3.435	3.488	3.542	3.595	3.649	60
70	3.649	3.702	3.756	3.809	3.863	3.917	3.971	4.024	4.078	4.132	4.186	70
80	4.186	4.239	4.293	4.347	4.401	4.455	4.509	4.563	4.617	4.671	4.725	80
90	4.725	4.780	4.834	4.888	4.942	4.996	5.050	5.105	5.159	5.213	5.268	90
100	5.268	5.322	5.376	5.431	5.485	5.540	5.594	5.649	5.703	5.758	5.812	100
110	5.812	5.867	5.921	5.976	6.031	6.085	6.140	6.195	6.249	6.304	6.359	110
120	6.359	6.414	6.468	6.523	6.578	6.633	6.688	6.742	6.797	6.852	6.907	120
130	6.907	6.962	7.017	7.072	7.127	7.182	7.237	7.292	7.347	7.402	7.457	130
140	7.457	7.512	7.567	7.622	7.677	7.732	7.787	7.843	7.898	7.953	8.008	140
150	8.008	8.063	8.118	8.174	8.229	8.284	8.339	8.394	8.450	8.505	8.560	150
160	8.560	8.616	8.671	8.726	8.781	8.837	8.892	8.947	9.003	9.058	9.113	160
170	9.113	9.169	9.224	9.279	9.335	9.390	9.446	9.501	9.556	9.612	9.667	170
180	9.667	9.723	9.778	9.834	9.889	9.944	10.000	10.055	10.111	10.166	10.222	180
190	10.222	10.277	10.333	10.388	10.444	10.499	10.555	10.610	10.666	10.721	10.777	190
200	10.777	10.832	10.888	10.943	10.999	11.054	11.110	11.165	11.221	11.276	11.332	200
210	11.332	11.387	11.443	11.498	11.554	11.609	11.665	11.720	11.776	11.831	11.887	210
220	11.887	11.943	11.998	12.054	12.109	12.165	12.220	12.276	12.331	12.387	12.442	220
230	12.442	12.498	12.553	12.609	12.664	12.720	12.776	12.831	12.887	12.942	12.998	230
240	12.998	13.053	13.109	13.164	13.220	13.275	13.331	13.386	13.442	13.497	13.553	240
250	13.553	13.608	13.664	13.719	13.775	13.830	13.886	13.941	13.997	14.052	14.108	250
260	14.108	14.163	14.219	14.274	14.330	14.385	14.441	14.496	14.552	14.607	14.663	260
270	14.663	14.718	14.774	14.829	14.885	14.940	14.995	15.051	15.106	15.162	15.217	270
280	15.217	15.273	15.328	15.383	15.439	15.494	15.550	15.605	15.661	15.716	15.771	280
290	15.771	15.827	15.882	15.938	15.993	16.048	16.104	16.159	16.214	16.270	16.325	290
300	16.325	16.380	16.436	16.491	16.547	16.602	16.657	16.713	16.768	16.823	16.879	300
310	16.879	16.934	16.989	17.044	17.100	17.155	17.210	17.266	17.321	17.376	17.432	310
320	17.432	17.487	17.542	17.597	17.653	17.708	17.763	17.818	17.874	17.929	17.984	320
330	17.984	18.039	18.095	18.150	18.205	18.260	18.316	18.371	18.426	18.481	18.537	330
340	18.537	18.592	18.647	18.702	18.757	18.813	18.868	18.923	18.978	19.033	19.089	340
350	19.089	19.144	19.199	19.254	19.309	19.364	19.420	19.475	19.530	19.585	19.640	350
360	19.640	19.695	19.751	19.806	19.861	19.916	19.971	20.026	20.081	20.137	20.192	360
370	20.192	20.247	20.302	20.357	20.412	20.467	20.523	20.578	20.633	20.688	20.743	370
380	20.743	20.798	20.853	20.909	20.964	21.019	21.074	21.129	21.184	21.239	21.295	380
390	21.295	21.350	21.405	21.460	21.515	21.570	21.625	21.680	21.736	21.791	21.846	390
400	21.846	21.901	21.956	22.011	22.066	22.122	22.177	22.232	22.287	22.342	22.397	400
410	22.397	22.453	22.508	22.563	22.618	22.673	22.728	22.784	22.839	22.894	22.949	410
420	22.949	23.004	23.060	23.115	23.170	23.225	23.280	23.336	23.391	23.446	23.501	420
430	23.501	23.556	23.612	23.667	23.722	23.777	23.833	23.888	23.943	23.999	24.054	430
440	24.054	24.109	24.164	24.220	24.275	24.330	24.386	24.441	24.496	24.552	24.607	440
450	24.607	24.662	24.718	24.773	24.829	24.884	24.939	24.995	25.050	25.106	25.161	450
460	25.161	25.217	25.272	25.327	25.383	25.438	25.494	25.549	25.605	25.661	25.716	460
470	25.716	25.772	25.827	25.883	25.938	25.994	26.050	26.105	26.161	26.216	26.272	470
480	26.272	26.328	26.383	26.439	26.495	26.551	26.606	26.662	26.718	26.774	26.829	480
490	26.829	26.885	26.941	26.997	27.053	27.109	27.165	27.220	27.276	27.332	27.388	490
500	27.388	27.444	27.500	27.556	27.612	27.668	27.724	27.780	27.836	27.893	27.949	500
510	27.949	28.005	28.061	28.117	28.173	28.230	28.286	28.342	28.398	28.455	28.511	510
520	28.511	28.567	28.624	28.680	28.736	28.793	28.849	28.906	28.962	29.019	29.075	520
530	29.075	29.132	29.188	29.245	29.301	29.358	29.415	29.471	29.528	29.585	29.642	530
540	29.642	29.698	29.755	29.812	29.869	29.926	29.983	30.039	30.096	30.153	30.210	540
550	30.210	30.267	30.324	30.381	30.439	30.496	30.553	30.610	30.667	30.724	30.782	550
560	30.782	30.839	30.896	30.954	31.011	31.068	31.126	31.183	31.241	31.298	31.356	560
570	31.356	31.413	31.471	31.528	31.586	31.644	31.702	31.759	31.817	31.875	31.933	570
580	31.933	31.991	32.048	32.106	32.164	32.222	32.280	32.338	32.396	32.455	32.513	580
590	32.513	32.571	32.629	32.687	32.746	32.804	32.862	32.921	32.979	33.038	33.096	590
600	33.096	33.155	33.213	33.272	33.330	33.389	33.448	33.506	33.565	33.624	33.683	600
610	33.683	33.742	33.800	33.859	33.918	33.977	34.036	34.095	34.155	34.214	34.273	610
620	34.273	34.332	34.391	34.451	34.510	34.569	34.629	34.688	34.748	34.807	34.867	620
630	34.867	34.926	34.986	35.046	35.105	35.165	35.225	35.285	35.344	35.404	35.464	630
640	35.464	35.524	35.584	35.644	35.704	35.764	35.825	35.885	35.945	36.005	36.066	640
650	36.066	36.126	36.186	36.247	36.307	36.368	36.428	36.489	36.549	36.610	36.671	650
660	36.671	36.732	36.792	36.853	36.914	36.975	37.036	37.097	37.158	37.219	37.280	660
670	37.280	37.341	37.402	37.463	37.525	37.586	37.647	37.709	37.770	37.831	37.893	670
680	37.893	37.954	38.016	38.078	38.139	38.201	38.262	38.324	38.386	38.448	38.510	680
690	38.510	38.572	38.633	38.695	38.757	38.819	38.882	38.944	39.006	39.068	39.130	690
700	39.130	39.192	39.255	39.317	39.379	39.442	39.504	39.567	39.629	39.692	39.754	700
710	39.754	39.817	39.880	39.942	40.005	40.068	40.131	40.193	40.256	40.319	40.382	710
720	40.382	40.445	40.508	40.571	40.634	40.697	40.760	40.823	40.886	40.950	41.013	720
730	41.013	41.076	41.139	41.203	41.266	41.329	41.393	41.456	41.520	41.583	41.647	730
740	41.647	41.710	41.774	41.837	41.901	41.965	42.028	42.092	42.156	42.219	42.283	740
750	42.283	42.347	42.411	42.475	42.538	42.602	42.666	42.730	42.794	42.858	42.922	750
760	42.922											760
DEG C	0	1	2	3	4	5	6	7	8	9	10	DEG C

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OMEGA
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TABLE II

TYPE K

New Reference Tables
Supersedes N.B.S.
Circular #561

Nickel-Chromium Vs. Nickel-Aluminum

(Chromel-Alumel)*

Temperature in Degrees C
Reference Junction at 0°C

THERMOELECTRIC VOLTAGE IN ABSOLUTE MILLIVOLTS

DEG C	0	1	2	3	4	5	6	7	8	9	10	DEG C
-270	-6.458											-270
-260	-6.441	-6.444	-6.446	-6.448	-6.450	-6.452	-6.453	-6.455	-6.456	-6.457	-6.458	-260
-250	-6.404	-6.408	-6.413	-6.417	-6.421	-6.425	-6.429	-6.432	-6.435	-6.438	-6.441	-250
-240	-6.344	-6.351	-6.358	-6.364	-6.371	-6.377	-6.382	-6.388	-6.394	-6.399	-6.404	-240
-230	-6.262	-6.271	-6.280	-6.289	-6.297	-6.306	-6.314	-6.322	-6.329	-6.337	-6.344	-230
-220	-6.158	-6.170	-6.181	-6.192	-6.202	-6.213	-6.223	-6.233	-6.243	-6.253	-6.262	-220
-210	-6.035	-6.048	-6.061	-6.074	-6.087	-6.099	-6.111	-6.123	-6.135	-6.147	-6.158	-210
-200	-5.891	-5.907	-5.922	-5.936	-5.951	-5.965	-5.980	-5.994	-6.007	-6.021	-6.035	-200
-190	-5.730	-5.747	-5.763	-5.780	-5.796	-5.813	-5.829	-5.845	-5.860	-5.876	-5.891	-190
-180	-5.550	-5.569	-5.587	-5.606	-5.624	-5.642	-5.660	-5.678	-5.695	-5.712	-5.730	-180
-170	-5.354	-5.374	-5.394	-5.414	-5.434	-5.454	-5.474	-5.493	-5.512	-5.531	-5.550	-170
-160	-5.141	-5.163	-5.185	-5.207	-5.228	-5.249	-5.271	-5.292	-5.313	-5.333	-5.354	-160
-150	-4.912	-4.936	-4.959	-4.983	-5.006	-5.029	-5.051	-5.074	-5.097	-5.119	-5.141	-150
-140	-4.669	-4.694	-4.719	-4.743	-4.768	-4.792	-4.817	-4.841	-4.865	-4.889	-4.912	-140
-130	-4.410	-4.437	-4.463	-4.489	-4.515	-4.541	-4.567	-4.593	-4.618	-4.644	-4.669	-130
-120	-4.138	-4.166	-4.193	-4.221	-4.248	-4.276	-4.303	-4.330	-4.357	-4.384	-4.410	-120
-110	-3.852	-3.881	-3.910	-3.939	-3.968	-3.997	-4.025	-4.053	-4.082	-4.110	-4.138	-110
-100	-3.553	-3.584	-3.614	-3.644	-3.674	-3.704	-3.734	-3.764	-3.793	-3.823	-3.852	-100
-90	-3.242	-3.274	-3.305	-3.337	-3.368	-3.399	-3.430	-3.461	-3.492	-3.523	-3.553	-90
-80	-2.920	-2.953	-2.985	-3.018	-3.050	-3.082	-3.115	-3.147	-3.179	-3.211	-3.242	-80
-70	-2.586	-2.620	-2.654	-2.687	-2.721	-2.754	-2.788	-2.821	-2.854	-2.887	-2.920	-70
-60	-2.243	-2.277	-2.312	-2.347	-2.381	-2.416	-2.450	-2.484	-2.518	-2.552	-2.586	-60
-50	-1.889	-1.925	-1.961	-1.996	-2.032	-2.067	-2.102	-2.137	-2.173	-2.208	-2.243	-50
-40	-1.527	-1.563	-1.600	-1.636	-1.673	-1.709	-1.745	-1.781	-1.817	-1.853	-1.889	-40
-30	-1.156	-1.193	-1.231	-1.268	-1.305	-1.342	-1.379	-1.416	-1.453	-1.490	-1.527	-30
-20	-0.777	-0.816	-0.854	-0.892	-0.930	-0.968	-1.005	-1.043	-1.081	-1.118	-1.156	-20
-10	-0.392	-0.431	-0.469	-0.508	-0.547	-0.585	-0.624	-0.662	-0.701	-0.739	-0.777	-10
0	0.000	-0.039	-0.079	-0.118	-0.157	-0.197	-0.236	-0.275	-0.314	-0.353	-0.392	0

DEG C	0	1	2	3	4	5	6	7	8	9	10	DEG C
0	0.000	0.039	0.079	0.119	0.158	0.198	0.238	0.277	0.317	0.357	0.397	0
10	0.397	0.437	0.477	0.517	0.557	0.597	0.637	0.677	0.718	0.758	0.798	10
20	0.798	0.838	0.879	0.919	0.960	1.000	1.041	1.081	1.122	1.162	1.203	20
30	1.203	1.244	1.285	1.325	1.366	1.407	1.448	1.489	1.529	1.570	1.611	30
40	1.611	1.652	1.693	1.734	1.776	1.817	1.858	1.899	1.940	1.981	2.022	40
50	2.022	2.064	2.105	2.146	2.188	2.229	2.270	2.312	2.353	2.394	2.436	50
60	2.436	2.477	2.519	2.560	2.601	2.643	2.684	2.726	2.767	2.809	2.850	60
70	2.850	2.892	2.933	2.975	3.016	3.058	3.100	3.141	3.183	3.224	3.266	70
80	3.266	3.307	3.349	3.390	3.432	3.473	3.515	3.556	3.598	3.639	3.681	80
90	3.681	3.722	3.764	3.805	3.847	3.888	3.930	3.971	4.012	4.054	4.095	90
100	4.095	4.137	4.178	4.219	4.261	4.302	4.343	4.384	4.426	4.467	4.508	100
110	4.508	4.549	4.590	4.632	4.673	4.714	4.755	4.796	4.837	4.878	4.919	110
120	4.919	4.960	5.001	5.042	5.083	5.124	5.164	5.205	5.246	5.287	5.327	120
130	5.327	5.368	5.409	5.450	5.490	5.531	5.571	5.612	5.652	5.693	5.733	130
140	5.733	5.774	5.814	5.855	5.895	5.936	5.976	6.016	6.057	6.097	6.137	140
150	6.137	6.177	6.218	6.258	6.298	6.338	6.378	6.419	6.459	6.499	6.539	150
160	6.539	6.579	6.619	6.659	6.699	6.739	6.779	6.819	6.859	6.899	6.939	160
170	6.939	6.979	7.019	7.059	7.099	7.139	7.179	7.219	7.259	7.299	7.338	170
180	7.338	7.378	7.418	7.458	7.498	7.538	7.578	7.618	7.658	7.697	7.737	180
190	7.737	7.777	7.817	7.857	7.897	7.937	7.977	8.017	8.057	8.097	8.137	190
200	8.137	8.177	8.216	8.256	8.296	8.336	8.376	8.416	8.456	8.497	8.537	200
210	8.537	8.577	8.617	8.657	8.697	8.737	8.777	8.817	8.857	8.898	8.938	210
220	8.938	8.978	9.018	9.058	9.099	9.139	9.179	9.220	9.260	9.300	9.341	220
230	9.341	9.381	9.421	9.462	9.502	9.543	9.583	9.624	9.664	9.705	9.745	230
240	9.745	9.786	9.826	9.867	9.907	9.948	9.989	10.029	10.070	10.111	10.151	240
250	10.151	10.192	10.233	10.274	10.315	10.355	10.396	10.437	10.478	10.519	10.560	250
260	10.560	10.600	10.641	10.682	10.723	10.764	10.805	10.846	10.887	10.928	10.969	260
270	10.969	11.010	11.051	11.093	11.134	11.175	11.216	11.257	11.298	11.339	11.381	270
280	11.381	11.422	11.463	11.504	11.546	11.587	11.628	11.669	11.711	11.752	11.793	280
290	11.793	11.835	11.876	11.918	11.959	12.000	12.042	12.083	12.125	12.166	12.207	290
300	12.207	12.249	12.290	12.332	12.373	12.415	12.456	12.498	12.539	12.581	12.623	300
310	12.623	12.664	12.706	12.747	12.789	12.831	12.872	12.914	12.955	12.997	13.039	310
320	13.039	13.080	13.122	13.164	13.205	13.247	13.289	13.331	13.372	13.414	13.456	320
330	13.456	13.497	13.539	13.581	13.623	13.665	13.706	13.748	13.790	13.832	13.874	330
340	13.874	13.915	13.957	13.999	14.041	14.083	14.125	14.167	14.208	14.250	14.292	340
350	14.292	14.334	14.376	14.418	14.460	14.502	14.544	14.586	14.628	14.670	14.712	350
360	14.712	14.754	14.796	14.838	14.880	14.922	14.964	15.006	15.048	15.090	15.132	360
370	15.132	15.174	15.216	15.258	15.300	15.342	15.384	15.426	15.468	15.510	15.552	370
380	15.552	15.594	15.636	15.679	15.721	15.763	15.805	15.847	15.889	15.931	15.974	380
390	15.974	16.016	16.058	16.100	16.142	16.184	16.227	16.269	16.311	16.353	16.395	390
400	16.395	16.438	16.480	16.522	16.564	16.607	16.649	16.691	16.733	16.776	16.818	400
410	16.818	16.860	16.902	16.945	16.987	17.029	17.072	17.114	17.156	17.199	17.241	410
420	17.241	17.283	17.326	17.368	17.410	17.453	17.495	17.537	17.580	17.622	17.664	420
430	17.664	17.707	17.749	17.792	17.834	17.876	17.919	17.961	18.004	18.046	18.088	430
440	18.088	18.131	18.173	18.216	18.258	18.301	18.343	18.385	18.428	18.470	18.513	440
450	18.513	18.555	18.598	18.640	18.683	18.725	18.768	18.810	18.853	18.895	18.938	450
460	18.938	18.980	19.023	19.065	19.108	19.150	19.193	19.235	19.278	19.320	19.363	460
470	19.363	19.405	19.448	19.490	19.533	19.576	19.618	19.661	19.703	19.746	19.788	470
480	19.788	19.831	19.873	19.916	19.959	20.001	20.044	20.086	20.129	20.172	20.214	480
490	20.214	20.257	20.299	20.342	20.385	20.427	20.470	20.512	20.555	20.598	20.640	490
500	20.640	20.683	20.725	20.768	20.811	20.853	20.896	20.938	20.981	21.024	21.066	500
510	21.066	21.109	21.152	21.194	21.237	21.280	21.322	21.365	21.407	21.450	21.493	510
520	21.493	21.535	21.578	21.621	21.663	21.706	21.749	21.791	21.834	21.876	21.919	520
530	21.919	21.962	22.004	22.047	22.090	22.132	22.175	22.218	22.260	22.303	22.346	530
540	22.346	22.388	22.431	22.473	22.516	22.559	22.601	22.644	22.687	22.729	22.772	540
550	22.772	22.815	22.857	22.900	22.942	22.985	23.028	23.070	23.113	23.156	23.198	550
560	23.198	23.241	23.284	23.326	23.369	23.411	23.454	23.497	23.539	23.582	23.624	560
570	23.624	23.667	23.710	23.752	23.795	23.837	23.880	23.923	23.965	24.008	24.050	570
580	24.050	24.093	24.136	24.178	24.221	24.263	24.306	24.348	24.391	24.434	24.476	580
590	24.476	24.519	24.561	24.604	24.646	24.689	24.731	24.774	24.817	24.859	24.902	590
600	24.902	24.944	24.987	25.029	25.072	25.114	25.157	25.199	25.242	25.284	25.327	600
DEG C	0	1	2	3	4	5	6	7	8	9	10	DEG C

*Equivalent material now available from other manufacturers. See "Trade Names of Alloys" table on page T-38.

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(203) 359-1660 Telex 996404 Cable OMEGA

TABLE II — Continued

TYPE K

New Reference Tables
Supersedes N.B.S.
Circular #561

Nickel-Chromium Vs. Nickel-Aluminum

(Chromel-Alumel)*

Temperature in Degrees C
Reference Junction at 0°C

THERMOELECTRIC VOLTAGE IN ABSOLUTE MILLIVOLTS

DEG C	0	1	2	3	4	5	6	7	8	9	10	DEG C
600	24.902	24.944	24.987	25.029	25.072	25.114	25.157	25.199	25.242	25.284	25.327	600
610	25.327	25.369	25.412	25.454	25.497	25.539	25.582	25.624	25.666	25.709	25.751	610
620	25.751	25.794	25.836	25.879	25.921	25.964	26.006	26.048	26.091	26.133	26.176	620
630	26.176	26.218	26.260	26.303	26.345	26.387	26.430	26.472	26.515	26.557	26.599	630
640	26.599	26.642	26.684	26.726	26.769	26.811	26.853	26.896	26.938	26.980	27.022	640
650	27.022	27.065	27.107	27.149	27.192	27.234	27.276	27.318	27.361	27.403	27.445	650
660	27.445	27.487	27.529	27.572	27.614	27.656	27.698	27.740	27.783	27.825	27.867	660
670	27.867	27.909	27.951	27.993	28.035	28.078	28.120	28.162	28.204	28.246	28.288	670
680	28.288	28.330	28.372	28.414	28.456	28.498	28.540	28.583	28.625	28.667	28.709	680
690	28.709	28.751	28.793	28.835	28.877	28.919	28.961	29.002	29.044	29.086	29.128	690
700	29.128	29.170	29.212	29.254	29.296	29.338	29.380	29.422	29.464	29.505	29.547	700
710	29.547	29.589	29.631	29.673	29.715	29.756	29.798	29.840	29.882	29.924	29.965	710
720	29.965	30.007	30.049	30.091	30.132	30.174	30.216	30.257	30.299	30.341	30.383	720
730	30.383	30.424	30.466	30.508	30.549	30.591	30.632	30.674	30.716	30.757	30.799	730
740	30.799	30.840	30.882	30.924	30.965	31.007	31.048	31.090	31.131	31.173	31.214	740
750	31.214	31.256	31.297	31.339	31.380	31.422	31.463	31.504	31.546	31.587	31.629	750
760	31.629	31.670	31.712	31.753	31.794	31.836	31.877	31.918	31.960	32.001	32.042	760
770	32.042	32.084	32.125	32.166	32.207	32.249	32.290	32.331	32.372	32.414	32.455	770
780	32.455	32.496	32.537	32.578	32.619	32.661	32.702	32.743	32.784	32.825	32.866	780
790	32.866	32.907	32.948	32.990	33.031	33.072	33.113	33.154	33.195	33.236	33.277	790
800	33.277	33.318	33.359	33.400	33.441	33.482	33.523	33.564	33.604	33.645	33.686	800
810	33.686	33.727	33.768	33.809	33.850	33.891	33.931	33.972	34.013	34.054	34.095	810
820	34.095	34.136	34.176	34.217	34.258	34.299	34.339	34.380	34.421	34.461	34.502	820
830	34.502	34.543	34.583	34.624	34.665	34.705	34.746	34.787	34.827	34.868	34.909	830
840	34.909	34.949	34.990	35.030	35.071	35.111	35.152	35.192	35.233	35.273	35.314	840
850	35.314	35.354	35.395	35.435	35.476	35.516	35.557	35.597	35.637	35.678	35.718	850
860	35.718	35.758	35.799	35.839	35.880	35.920	35.960	36.000	36.041	36.081	36.121	860
870	36.121	36.162	36.202	36.242	36.282	36.323	36.363	36.403	36.443	36.483	36.524	870
880	36.524	36.564	36.604	36.644	36.684	36.724	36.764	36.804	36.844	36.885	36.925	880
890	36.925	36.965	37.005	37.045	37.085	37.125	37.165	37.205	37.245	37.285	37.325	890
900	37.325	37.365	37.405	37.445	37.484	37.524	37.564	37.604	37.644	37.684	37.724	900
910	37.724	37.764	37.803	37.843	37.883	37.923	37.963	38.002	38.042	38.082	38.122	910
920	38.122	38.162	38.201	38.241	38.281	38.320	38.360	38.400	38.439	38.479	38.519	920
930	38.519	38.558	38.598	38.638	38.677	38.717	38.756	38.796	38.836	38.875	38.915	930
940	38.915	38.954	38.994	39.033	39.073	39.112	39.152	39.191	39.231	39.270	39.310	940
950	39.310	39.349	39.388	39.428	39.467	39.507	39.546	39.585	39.625	39.664	39.703	950
960	39.703	39.743	39.782	39.821	39.861	39.900	39.939	39.979	40.018	40.057	40.096	960
970	40.096	40.136	40.175	40.214	40.253	40.292	40.332	40.371	40.410	40.449	40.488	970
980	40.488	40.527	40.566	40.605	40.645	40.684	40.723	40.762	40.801	40.840	40.879	980
990	40.879	40.918	40.957	40.996	41.035	41.074	41.113	41.152	41.191	41.230	41.269	990
1,000	41.269	41.308	41.347	41.385	41.424	41.463	41.502	41.541	41.580	41.619	41.657	1,000
1,010	41.657	41.696	41.735	41.774	41.813	41.851	41.890	41.929	41.968	42.006	42.045	1,010
1,020	42.045	42.084	42.123	42.161	42.200	42.239	42.277	42.316	42.355	42.393	42.432	1,020
1,030	42.432	42.470	42.509	42.548	42.586	42.625	42.663	42.702	42.740	42.779	42.817	1,030
1,040	42.817	42.856	42.894	42.933	42.971	43.010	43.048	43.087	43.125	43.164	43.202	1,040
1,050	43.202	43.240	43.279	43.317	43.356	43.394	43.432	43.471	43.509	43.547	43.585	1,050
1,060	43.585	43.624	43.662	43.700	43.739	43.777	43.815	43.853	43.891	43.930	43.968	1,060
1,070	43.968	44.006	44.044	44.082	44.121	44.159	44.197	44.235	44.273	44.311	44.349	1,070
1,080	44.349	44.387	44.425	44.463	44.501	44.539	44.577	44.615	44.653	44.691	44.729	1,080
1,090	44.729	44.767	44.805	44.843	44.881	44.919	44.957	44.995	45.033	45.070	45.108	1,090
1,100	45.108	45.146	45.184	45.222	45.260	45.297	45.335	45.373	45.411	45.448	45.486	1,100
1,110	45.486	45.524	45.561	45.599	45.637	45.675	45.712	45.750	45.787	45.825	45.863	1,110
1,120	45.863	45.900	45.938	45.975	46.013	46.051	46.088	46.126	46.163	46.201	46.238	1,120
1,130	46.238	46.275	46.313	46.350	46.388	46.425	46.463	46.500	46.537	46.575	46.612	1,130
1,140	46.612	46.649	46.687	46.724	46.761	46.799	46.836	46.873	46.910	46.948	46.985	1,140
1,150	46.985	47.022	47.059	47.096	47.134	47.171	47.208	47.245	47.282	47.319	47.356	1,150
1,160	47.356	47.393	47.430	47.468	47.505	47.542	47.579	47.616	47.653	47.689	47.726	1,160
1,170	47.726	47.763	47.800	47.837	47.874	47.911	47.948	47.985	48.021	48.058	48.095	1,170
1,180	48.095	48.132	48.169	48.205	48.242	48.279	48.316	48.352	48.389	48.426	48.462	1,180
1,190	48.462	48.499	48.536	48.572	48.609	48.645	48.682	48.718	48.755	48.792	48.828	1,190
1,200	48.828	48.865	48.901	48.937	48.974	49.010	49.047	49.083	49.120	49.156	49.192	1,200
1,210	49.192	49.229	49.265	49.301	49.338	49.374	49.410	49.446	49.483	49.519	49.555	1,210
1,220	49.555	49.591	49.627	49.663	49.700	49.736	49.772	49.808	49.844	49.880	49.916	1,220
1,230	49.916	49.952	49.988	50.024	50.060	50.096	50.132	50.168	50.204	50.240	50.276	1,230
1,240	50.276	50.311	50.347	50.383	50.419	50.455	50.491	50.526	50.562	50.598	50.633	1,240
1,250	50.633	50.669	50.705	50.741	50.776	50.812	50.847	50.883	50.919	50.954	50.990	1,250
1,260	50.990	51.025	51.061	51.096	51.132	51.167	51.203	51.238	51.274	51.309	51.344	1,260
1,270	51.344	51.380	51.415	51.450	51.486	51.521	51.556	51.592	51.627	51.662	51.697	1,270
1,280	51.697	51.733	51.768	51.803	51.838	51.873	51.908	51.943	51.979	52.014	52.049	1,280
1,290	52.049	52.084	52.119	52.154	52.189	52.224	52.259	52.294	52.329	52.364	52.398	1,290
1,300	52.398	52.433	52.468	52.503	52.538	52.573	52.608	52.642	52.677	52.712	52.747	1,300
1,310	52.747	52.781	52.816	52.851	52.886	52.920	52.955	52.989	53.024	53.059	53.093	1,310
1,320	53.093	53.128	53.162	53.197	53.232	53.266	53.301	53.335	53.370	53.404	53.439	1,320
1,330	53.439	53.473	53.507	53.542	53.576	53.611	53.645	53.679	53.714	53.748	53.782	1,330
1,340	53.782	53.817	53.851	53.885	53.920	53.954	53.988	54.022	54.057	54.091	54.125	1,340
1,350	54.125	54.159	54.193	54.228	54.262	54.296	54.330	54.364	54.398	54.432	54.466	1,350
1,360	54.466	54.501	54.535	54.569	54.603	54.637	54.671	54.705	54.739	54.773	54.807	1,360
1,370	54.807	54.841	54.875									1,370
DEG C	0	1	2	3	4	5	6	7	8	9	10	DEG C

*Equivalent material now available from other manufacturers. See "Trade Names of Alloys" table on page T-38.

OMEGA ENGINEERING, INC.
An OMEGA Group Company
One Omega Drive, Box 4047, Stamford, CT 06907
(203) 359-1660 Telex 996404 Cable OMEGA

TABLE III

TYPE E

New Reference Tables
Supersedes N.B.S.
Circular #561

Nickel-Chromium Vs. Copper-Nickel

(Chromel-Constantan)

Temperature in Degrees C
Reference Junction at 0°C

THERMOELECTRIC VOLTAGE IN ABSOLUTE MILLIVOLTS

DEG C	0	1	2	3	4	5	6	7	8	9	10	DEG C
-270	-9.835											-270
-260	-9.797	-9.802	-9.808	-9.813	-9.817	-9.821	-9.825	-9.828	-9.831	-9.833	-9.835	-260
-250	-9.719	-9.728	-9.737	-9.746	-9.754	-9.762	-9.770	-9.777	-9.784	-9.791	-9.797	-250
-240	-9.604	-9.617	-9.630	-9.642	-9.654	-9.666	-9.677	-9.688	-9.699	-9.709	-9.719	-240
-230	-9.455	-9.472	-9.488	-9.503	-9.519	-9.534	-9.549	-9.563	-9.577	-9.591	-9.604	-230
-220	-9.274	-9.293	-9.313	-9.332	-9.350	-9.368	-9.386	-9.404	-9.421	-9.438	-9.455	-220
-210	-9.063	-9.085	-9.107	-9.129	-9.151	-9.172	-9.193	-9.214	-9.234	-9.254	-9.274	-210
-200	-8.824	-8.850	-8.874	-8.899	-8.923	-8.947	-8.971	-8.994	-9.017	-9.040	-9.063	-200
-190	-8.561	-8.588	-8.615	-8.642	-8.669	-8.696	-8.722	-8.748	-8.774	-8.799	-8.824	-190
-180	-8.273	-8.303	-8.333	-8.362	-8.391	-8.420	-8.449	-8.477	-8.505	-8.533	-8.561	-180
-170	-7.963	-7.995	-8.027	-8.058	-8.090	-8.121	-8.152	-8.183	-8.213	-8.243	-8.273	-170
-160	-7.631	-7.665	-7.699	-7.733	-7.767	-7.800	-7.833	-7.866	-7.898	-7.931	-7.963	-160
-150	-7.279	-7.315	-7.351	-7.387	-7.422	-7.458	-7.493	-7.528	-7.562	-7.597	-7.631	-150
-140	-6.907	-6.945	-6.983	-7.020	-7.058	-7.095	-7.132	-7.169	-7.206	-7.243	-7.279	-140
-130	-6.516	-6.556	-6.596	-6.635	-6.675	-6.714	-6.753	-6.792	-6.830	-6.869	-6.907	-130
-120	-6.107	-6.149	-6.190	-6.231	-6.273	-6.314	-6.354	-6.395	-6.436	-6.476	-6.516	-120
-110	-5.680	-5.724	-5.767	-5.810	-5.853	-5.896	-5.938	-5.981	-6.023	-6.065	-6.107	-110
-100	-5.237	-5.282	-5.327	-5.371	-5.416	-5.460	-5.505	-5.549	-5.593	-5.637	-5.680	-100
-90	-4.777	-4.824	-4.870	-4.916	-4.963	-5.009	-5.055	-5.100	-5.146	-5.191	-5.237	-90
-80	-4.301	-4.350	-4.398	-4.446	-4.493	-4.541	-4.588	-4.636	-4.683	-4.730	-4.777	-80
-70	-3.811	-3.860	-3.910	-3.959	-4.009	-4.058	-4.107	-4.156	-4.204	-4.253	-4.301	-70
-60	-3.306	-3.357	-3.408	-3.459	-3.509	-3.560	-3.610	-3.661	-3.711	-3.761	-3.811	-60
-50	-2.787	-2.839	-2.892	-2.944	-2.996	-3.048	-3.100	-3.152	-3.203	-3.254	-3.306	-50
-40	-2.254	-2.308	-2.362	-2.416	-2.469	-2.522	-2.575	-2.628	-2.681	-2.734	-2.787	-40
-30	-1.709	-1.764	-1.819	-1.874	-1.929	-1.983	-2.038	-2.092	-2.146	-2.200	-2.254	-30
-20	-1.151	-1.208	-1.264	-1.320	-1.376	-1.432	-1.487	-1.543	-1.599	-1.654	-1.709	-20
-10	-0.581	-0.639	-0.696	-0.754	-0.811	-0.868	-0.925	-0.982	-1.038	-1.095	-1.151	-10
0	0.000	-0.059	-0.117	-0.176	-0.234	-0.292	-0.350	-0.408	-0.466	-0.524	-0.581	0

DEG C	0	1	2	3	4	5	6	7	8	9	10	DEG C
0	0.000	0.059	0.118	0.176	0.235	0.295	0.354	0.413	0.472	0.532	0.591	0
10	0.591	0.651	0.711	0.770	0.830	0.890	0.950	1.011	1.071	1.131	1.192	10
20	1.192	1.252	1.313	1.373	1.434	1.495	1.556	1.617	1.678	1.739	1.801	20
30	1.801	1.862	1.924	1.985	2.047	2.109	2.171	2.233	2.295	2.357	2.419	30
40	2.419	2.482	2.544	2.607	2.669	2.732	2.795	2.858	2.921	2.984	3.047	40
50	3.047	3.110	3.173	3.237	3.300	3.364	3.428	3.491	3.555	3.619	3.683	50
60	3.683	3.748	3.812	3.876	3.941	4.005	4.070	4.134	4.199	4.264	4.329	60
70	4.329	4.394	4.459	4.524	4.590	4.655	4.720	4.786	4.852	4.917	4.983	70
80	4.983	5.049	5.115	5.181	5.247	5.314	5.380	5.446	5.513	5.579	5.646	80
90	5.646	5.713	5.780	5.846	5.913	5.981	6.048	6.115	6.182	6.250	6.317	90
100	6.317	6.385	6.452	6.520	6.588	6.656	6.724	6.792	6.860	6.928	6.996	100
110	6.996	7.064	7.133	7.201	7.270	7.339	7.407	7.476	7.545	7.614	7.683	110
120	7.683	7.752	7.821	7.890	7.960	8.029	8.099	8.168	8.238	8.307	8.377	120
130	8.377	8.447	8.517	8.587	8.657	8.727	8.797	8.867	8.938	9.008	9.078	130
140	9.078	9.149	9.220	9.290	9.361	9.432	9.503	9.573	9.644	9.715	9.787	140
150	9.787	9.858	9.929	10.000	10.072	10.143	10.215	10.286	10.358	10.429	10.501	150
160	10.501	10.573	10.645	10.717	10.789	10.861	10.933	11.005	11.077	11.150	11.222	160
170	11.222	11.294	11.367	11.439	11.512	11.585	11.657	11.730	11.803	11.876	11.949	170
180	11.949	12.022	12.095	12.168	12.241	12.314	12.387	12.461	12.534	12.608	12.681	180
190	12.681	12.755	12.828	12.902	12.975	13.049	13.123	13.197	13.271	13.345	13.419	190
200	13.419	13.493	13.567	13.641	13.715	13.789	13.864	13.938	14.012	14.087	14.161	200
210	14.161	14.236	14.310	14.385	14.460	14.534	14.609	14.684	14.759	14.834	14.909	210
220	14.909	14.984	15.059	15.134	15.209	15.284	15.359	15.435	15.510	15.585	15.661	220
230	15.661	15.736	15.812	15.887	15.963	16.038	16.114	16.190	16.266	16.341	16.417	230
240	16.417	16.493	16.569	16.645	16.721	16.797	16.873	16.949	17.025	17.101	17.178	240
250	17.178	17.254	17.330	17.406	17.483	17.559	17.636	17.712	17.789	17.865	17.942	250
260	17.942	18.018	18.095	18.172	18.248	18.325	18.402	18.479	18.556	18.633	18.710	260
270	18.710	18.787	18.864	18.941	19.018	19.095	19.172	19.249	19.326	19.404	19.481	270
280	19.481	19.558	19.636	19.713	19.790	19.868	19.945	20.023	20.100	20.178	20.256	280
290	20.256	20.333	20.411	20.488	20.566	20.644	20.722	20.800	20.877	20.955	21.033	290
300	21.033	21.111	21.189	21.267	21.345	21.423	21.501	21.579	21.657	21.735	21.814	300
310	21.814	21.892	21.970	22.048	22.127	22.205	22.283	22.362	22.440	22.518	22.597	310
320	22.597	22.675	22.754	22.832	22.911	22.989	23.068	23.147	23.225	23.304	23.383	320
330	23.383	23.461	23.540	23.619	23.698	23.777	23.855	23.934	24.013	24.092	24.171	330
340	24.171	24.250	24.329	24.408	24.487	24.566	24.645	24.724	24.803	24.882	24.961	340
350	24.961	25.041	25.120	25.199	25.278	25.357	25.437	25.516	25.595	25.675	25.754	350
360	25.754	25.833	25.913	25.992	26.072	26.151	26.230	26.310	26.389	26.469	26.549	360
370	26.549	26.628	26.708	26.787	26.867	26.947	27.026	27.106	27.186	27.265	27.345	370
380	27.345	27.425	27.504	27.584	27.664	27.744	27.824	27.903	27.983	28.063	28.143	380
390	28.143	28.223	28.303	28.383	28.463	28.543	28.623	28.703	28.783	28.863	28.943	390
400	28.943	29.023	29.103	29.183	29.263	29.343	29.423	29.503	29.584	29.664	29.744	400
410	29.744	29.824	29.904	29.984	30.065	30.145	30.225	30.305	30.386	30.466	30.546	410
420	30.546	30.627	30.707	30.787	30.868	30.948	31.028	31.109	31.189	31.270	31.350	420
430	31.350	31.430	31.511	31.591	31.672	31.752	31.833	31.913	31.994	32.074	32.155	430
440	32.155	32.235	32.316	32.396	32.477	32.557	32.638	32.719	32.799	32.880	32.960	440
450	32.960	33.041	33.122	33.202	33.283	33.364	33.444	33.525	33.605	33.686	33.767	450
460	33.767	33.848	33.928	34.009	34.090	34.170	34.251	34.332	34.413	34.493	34.574	460
470	34.574	34.655	34.736	34.816	34.897	34.978	35.059	35.140	35.220	35.301	35.382	470
480	35.382	35.463	35.544	35.624	35.705	35.786	35.867	35.948	36.029	36.109	36.190	480
490	36.190	36.271	36.352	36.433	36.514	36.595	36.675	36.756	36.837	36.918	36.999	490
500	36.999	37.080	37.161	37.242	37.323	37.403	37.484	37.565	37.646	37.727	37.808	500
510	37.808	37.889	37.970	38.051	38.132	38.213	38.293	38.374	38.455	38.536	38.617	510
520	38.617	38.698	38.779	38.860	38.941	39.022	39.103	39.184	39.264	39.345	39.426	520
530	39.426	39.507	39.588	39.669	39.750	39.831	39.912	39.993	40.074	40.155	40.236	530
540	40.236	40.316	40.397	40.478	40.559	40.640	40.721	40.802	40.883	40.964	41.045	540
550	41.045	41.125	41.206	41.287	41.368	41.449	41.530	41.611	41.692	41.773	41.853	550
560	41.853	41.934	42.015	42.096	42.177	42.258	42.339	42.419	42.500	42.581	42.662	560
570	42.662	42.743	42.824	42.904	42.985	43.066	43.147	43.228	43.308	43.389	43.470	570
580	43.470	43.551	43.632	43.712	43.793	43.874	43.955	44.035	44.116	44.197	44.278	580
590	44.278	44.358	44.439	44.520	44.601	44.681	44.762	44.843	44.923	45.004	45.085	590
600	45.085	45.165	45.246	45.327	45.407	45.488	45.569	45.649	45.730	45.811	45.891	600
610	45.891	45.972	46.052	46.133	46.213	46.294	46.375	46.455	46.536	46.616	46.697	610
620	46.697	46.777	46.858	46.938	47.019	47.099	47.180	47.260	47.341	47.421	47.502	620
630	47.502	47.582	47.663	47.743	47.824	47.904	47.984	48.065	48.145	48.226	48.306	630
640	48.306	48.386	48.467	48.547	48.627	48.708	48.788	48.868	48.949	49.029	49.109	640
650	49.109	49.189	49.270	49.350	49.430	49.510	49.591	49.671	49.751	49.831	49.911	650
660	49.911	49.992	50.072	50.152	50.232	50.312	50.392	50.472	50.553	50.633	50.713	660
670	50.713	50.793	50.873	50.953	51.033	51.113	51.193	51.273	51.353	51.433	51.513	670
680	51.513	51.593	51.673	51.753	51.833	51.913	51.993	52.073	52.152	52.232	52.312	680
690	52.312	52.392	52.472	52.552	52.632	52.711	52.791	52.871	52.951	53.031	53.110	690
700	53.110	53.190	53.270	53.350	53.429	53.509	53.589	53.668	53.748	53.828	53.907	700
710	53.907	53.987	54.066	54.146	54.226	54.305	54.385	54.464	54.544	54.623	54.703	710
720	54.703	54.782	54.862	54.941	55.021	55.100	55.180	55.259	55.339	55.418	55.498	720
730	55.498	55.577	55.656	55.736	55.815	55.894	55.974	56.053	56.132	56.212	56.291	730
740	56.291	56.370	56.449	56.529	56.608	56.687	56.766	56.845	56.924	57.004	57.083	740
750	57.083	57.162	57.241	57.320	57.399	57.478	57.557	57.636	57.715	57.794	57.873	750
760	57.873	57.952	58.031	58.110	58.189	58.268	58.347	58.426	58.505	58.584	58.663	760
770	58.663	58.742	58.820	58.899	58.978	59.057	59.136	59.214	59.293	59.372	59.451	770
780	59.451	59.529	59.608	59.687	59.765	59.844	59.923	60.001	60.080	60.159	60.237	780
790	60.237	60.316	60.394	60.473	60.551	60.630	60.708	60.787	60.865	60.944	61.022	790
DEG C	0	1	2	3	4	5	6	7	8	9	10	DEG C

OMEGA®
ENGINEERING, INC.
An OMEGA Group Company
One Omega Drive, Box 4047, Stamford, CT 06907
(203) 359-1660 Telex 996404 Cable OMEGA

TABLE III — Continued

TYPE E

New Reference Tables
Supersedes N.B.S.
Circular #561

THERMOELECTRIC VOLTAGE IN ABSOLUTE MILLIVOLTS

DEG C	0	1	2	3	4	5	6	7	8	9	10	DEG C
800	61.022	61.101	61.179	61.258	61.336	61.414	61.493	61.571	61.649	61.728	61.806	800
810	61.806	61.884	61.962	62.041	62.119	62.197	62.275	62.353	62.432	62.510	62.588	810
820	62.588	62.666	62.744	62.822	62.900	62.978	63.056	63.134	63.212	63.290	63.368	820
830	63.368	63.446	63.524	63.602	63.680	63.758	63.836	63.914	63.992	64.069	64.147	830
840	64.147	64.225	64.303	64.380	64.458	64.536	64.614	64.691	64.769	64.847	64.924	840
850	64.924	65.002	65.080	65.157	65.235	65.312	65.390	65.467	65.545	65.622	65.700	850
860	65.700	65.777	65.855	65.932	66.009	66.087	66.164	66.241	66.319	66.396	66.473	860
870	66.473	66.551	66.628	66.705	66.782	66.859	66.937	67.014	67.091	67.168	67.245	870
880	67.245	67.322	67.399	67.476	67.553	67.630	67.707	67.784	67.861	67.938	68.015	880
890	68.015	68.092	68.169	68.246	68.323	68.399	68.476	68.553	68.630	68.706	68.783	890
900	68.783	68.860	68.936	69.013	69.090	69.166	69.243	69.320	69.396	69.473	69.549	900
910	69.549	69.626	69.702	69.779	69.855	69.931	70.008	70.084	70.161	70.237	70.313	910
920	70.313	70.390	70.466	70.542	70.618	70.694	70.771	70.847	70.923	70.999	71.075	920
930	71.075	71.151	71.227	71.304	71.380	71.456	71.532	71.608	71.683	71.759	71.835	930
940	71.835	71.911	71.987	72.063	72.139	72.215	72.290	72.366	72.442	72.518	72.593	940
950	72.593	72.669	72.745	72.820	72.896	72.972	73.047	73.123	73.199	73.274	73.350	950
960	73.350	73.425	73.501	73.576	73.652	73.727	73.802	73.878	73.953	74.029	74.104	960
970	74.104	74.179	74.255	74.330	74.405	74.480	74.556	74.631	74.706	74.781	74.857	970
980	74.857	74.932	75.007	75.082	75.157	75.232	75.307	75.382	75.458	75.533	75.608	980
990	75.608	75.683	75.758	75.833	75.908	75.983	76.058	76.133	76.208	76.283	76.358	990
1,000	76.358											1,000
DEG C	0	1	2	3	4	5	6	7	8	9	10	DEG C

TABLE IV

TYPE T

New Reference Tables
Supersedes N.B.S.
Circular #561

Copper Vs. Copper-Nickel

(Copper-Constantan)

Temperature in Degrees C
Reference Junction at 0°C

THERMOELECTRIC VOLTAGE IN ABSOLUTE MILL VOLTS

DEG C	0	1	2	3	4	5	6	7	8	9	10	DEG C
-270	-6.258											-270
-260	-6.232	-6.236	-6.239	-6.242	-6.245	-6.248	-6.251	-6.253	-6.255	-6.256	-6.258	-260
-250	-6.181	-6.187	-6.193	-6.198	-6.204	-6.209	-6.214	-6.219	-6.224	-6.228	-6.232	-250
-240	-6.105	-6.114	-6.122	-6.130	-6.138	-6.146	-6.153	-6.160	-6.167	-6.174	-6.181	-240
-230	-6.007	-6.018	-6.028	-6.039	-6.049	-6.059	-6.068	-6.078	-6.087	-6.096	-6.105	-230
-220	-5.889	-5.901	-5.914	-5.926	-5.938	-5.950	-5.962	-5.973	-5.985	-5.996	-6.007	-220
-210	-5.753	-5.767	-5.782	-5.795	-5.809	-5.823	-5.836	-5.850	-5.863	-5.876	-5.889	-210
-200	-5.603	-5.619	-5.634	-5.650	-5.665	-5.680	-5.695	-5.710	-5.724	-5.739	-5.753	-200
-190	-5.439	-5.456	-5.473	-5.489	-5.506	-5.522	-5.539	-5.555	-5.571	-5.587	-5.603	-190
-180	-5.261	-5.279	-5.297	-5.315	-5.333	-5.351	-5.369	-5.387	-5.404	-5.421	-5.439	-180
-170	-5.069	-5.089	-5.109	-5.128	-5.147	-5.167	-5.186	-5.205	-5.223	-5.242	-5.261	-170
-160	-4.865	-4.886	-4.907	-4.928	-4.948	-4.969	-4.989	-5.010	-5.030	-5.050	-5.069	-160
-150	-4.648	-4.670	-4.693	-4.715	-4.737	-4.758	-4.780	-4.801	-4.823	-4.844	-4.865	-150
-140	-4.419	-4.442	-4.466	-4.489	-4.512	-4.535	-4.558	-4.581	-4.603	-4.626	-4.648	-140
-130	-4.177	-4.202	-4.226	-4.251	-4.275	-4.299	-4.323	-4.347	-4.371	-4.395	-4.419	-130
-120	-3.923	-3.949	-3.974	-4.000	-4.026	-4.051	-4.077	-4.102	-4.127	-4.152	-4.177	-120
-110	-3.656	-3.684	-3.711	-3.737	-3.764	-3.791	-3.818	-3.844	-3.870	-3.897	-3.923	-110
-100	-3.378	-3.407	-3.435	-3.463	-3.491	-3.519	-3.547	-3.574	-3.602	-3.629	-3.656	-100
-90	-3.089	-3.118	-3.147	-3.177	-3.206	-3.235	-3.264	-3.293	-3.321	-3.350	-3.378	-90
-80	-2.788	-2.818	-2.849	-2.879	-2.909	-2.939	-2.970	-2.999	-3.029	-3.059	-3.089	-80
-70	-2.475	-2.507	-2.539	-2.570	-2.602	-2.633	-2.664	-2.695	-2.726	-2.757	-2.788	-70
-60	-2.152	-2.185	-2.218	-2.250	-2.283	-2.315	-2.348	-2.380	-2.412	-2.444	-2.475	-60
-50	-1.819	-1.853	-1.886	-1.920	-1.953	-1.987	-2.020	-2.053	-2.087	-2.120	-2.152	-50
-40	-1.475	-1.510	-1.544	-1.579	-1.614	-1.648	-1.682	-1.717	-1.751	-1.785	-1.819	-40
-30	-1.121	-1.157	-1.192	-1.228	-1.263	-1.299	-1.334	-1.370	-1.405	-1.440	-1.475	-30
-20	-0.757	-0.794	-0.830	-0.867	-0.903	-0.940	-0.976	-1.013	-1.049	-1.085	-1.121	-20
-10	-0.383	-0.421	-0.458	-0.496	-0.534	-0.571	-0.608	-0.646	-0.683	-0.720	-0.757	-10
0	0.000	-0.039	-0.077	-0.116	-0.154	-0.193	-0.231	-0.269	-0.307	-0.345	-0.383	0
DEG C	0	1	2	3	4	5	6	7	8	9	10	DEG C
0	0.000	0.039	0.078	0.117	0.156	0.195	0.234	0.273	0.312	0.351	0.391	0
10	0.391	0.430	0.470	0.510	0.549	0.589	0.629	0.669	0.709	0.749	0.789	10
20	0.789	0.830	0.870	0.911	0.951	0.992	1.032	1.073	1.114	1.155	1.196	20
30	1.196	1.237	1.279	1.320	1.361	1.403	1.444	1.486	1.528	1.569	1.611	30
40	1.611	1.653	1.695	1.738	1.780	1.822	1.865	1.907	1.950	1.992	2.035	40
50	2.035	2.078	2.121	2.164	2.207	2.250	2.294	2.337	2.380	2.424	2.467	50
60	2.467	2.511	2.555	2.599	2.643	2.687	2.731	2.775	2.819	2.864	2.908	60
70	2.908	2.953	2.997	3.042	3.087	3.131	3.176	3.221	3.266	3.312	3.357	70
80	3.357	3.402	3.447	3.493	3.538	3.584	3.630	3.676	3.721	3.767	3.813	80
90	3.813	3.859	3.906	3.952	3.998	4.044	4.091	4.137	4.184	4.231	4.277	90
100	4.277	4.324	4.371	4.418	4.465	4.512	4.559	4.607	4.654	4.701	4.749	100
110	4.749	4.796	4.844	4.891	4.939	4.987	5.035	5.083	5.131	5.179	5.227	110
120	5.227	5.275	5.324	5.372	5.420	5.469	5.517	5.566	5.615	5.663	5.712	120
130	5.712	5.761	5.810	5.859	5.908	5.957	6.007	6.056	6.105	6.155	6.204	130
140	6.204	6.254	6.303	6.353	6.403	6.452	6.502	6.552	6.602	6.652	6.702	140
150	6.702	6.753	6.803	6.853	6.903	6.954	7.004	7.055	7.106	7.156	7.207	150
160	7.207	7.258	7.309	7.360	7.411	7.462	7.513	7.564	7.615	7.666	7.718	160
170	7.718	7.769	7.821	7.872	7.924	7.975	8.027	8.079	8.131	8.183	8.235	170
180	8.235	8.287	8.339	8.391	8.443	8.495	8.548	8.600	8.652	8.705	8.757	180
190	8.757	8.810	8.863	8.915	8.968	9.021	9.074	9.127	9.180	9.233	9.286	190
200	9.286	9.339	9.392	9.446	9.499	9.553	9.606	9.659	9.713	9.767	9.820	200
210	9.820	9.874	9.928	9.982	10.036	10.090	10.144	10.198	10.252	10.306	10.360	210
220	10.360	10.414	10.469	10.523	10.578	10.632	10.687	10.741	10.796	10.851	10.905	220
230	10.905	10.960	11.015	11.070	11.125	11.180	11.235	11.290	11.345	11.401	11.456	230
240	11.456	11.511	11.566	11.622	11.677	11.733	11.788	11.844	11.900	11.956	12.011	240
250	12.011	12.067	12.123	12.179	12.235	12.291	12.347	12.403	12.459	12.515	12.572	250
260	12.572	12.628	12.684	12.741	12.797	12.854	12.910	12.967	13.024	13.080	13.137	260
270	13.137	13.194	13.251	13.307	13.364	13.421	13.478	13.535	13.592	13.650	13.707	270
280	13.707	13.764	13.821	13.879	13.936	13.993	14.051	14.108	14.166	14.223	14.281	280
290	14.281	14.339	14.396	14.454	14.512	14.570	14.628	14.686	14.744	14.802	14.860	290
300	14.860	14.918	14.976	15.034	15.092	15.151	15.209	15.267	15.326	15.384	15.443	300
310	15.443	15.501	15.560	15.619	15.677	15.736	15.795	15.853	15.912	15.971	16.030	310
320	16.030	16.089	16.148	16.207	16.266	16.325	16.384	16.444	16.503	16.562	16.621	320
330	16.621	16.681	16.740	16.800	16.859	16.919	16.978	17.038	17.097	17.157	17.217	330
340	17.217	17.277	17.336	17.396	17.456	17.516	17.576	17.636	17.696	17.756	17.816	340
350	17.816	17.877	17.937	17.997	18.057	18.118	18.178	18.238	18.299	18.359	18.420	350
360	18.420	18.480	18.541	18.602	18.662	18.723	18.784	18.845	18.905	18.966	19.027	360
370	19.027	19.088	19.149	19.210	19.271	19.332	19.393	19.455	19.516	19.577	19.638	370
380	19.638	19.699	19.761	19.822	19.883	19.945	20.006	20.068	20.129	20.191	20.252	380
390	20.252	20.314	20.376	20.437	20.499	20.560	20.622	20.684	20.746	20.807	20.869	390
400	20.869											400
DEG C	0	1	2	3	4	5	6	7	8	9	10	DEG C

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TABLE V

TYPE S

New Reference Tables
Supersedes N.B.S.
Circular #561

Platinum Vs. Platinum-10% Rhodium

Temperature in Degrees C
Reference Junction at 0°C

THERMOELECTRIC VOLTAGE IN ABSOLUTE MILLIVOLTS

DEG C	0	1	2	3	4	5	6	7	8	9	10	DEG C
0	0.000	0.005	0.011	0.016	0.022	0.027	0.033	0.038	0.044	0.050	0.055	0
10	0.055	0.061	0.067	0.072	0.078	0.084	0.090	0.095	0.101	0.107	0.113	10
20	0.113	0.119	0.125	0.131	0.137	0.142	0.148	0.154	0.161	0.167	0.173	20
30	0.173	0.179	0.185	0.191	0.197	0.203	0.210	0.216	0.222	0.228	0.235	30
40	0.235	0.241	0.247	0.254	0.260	0.266	0.273	0.279	0.286	0.292	0.299	40
50	0.299	0.305	0.312	0.318	0.325	0.331	0.338	0.345	0.351	0.358	0.365	50
60	0.365	0.371	0.378	0.385	0.391	0.398	0.405	0.412	0.419	0.425	0.432	60
70	0.432	0.439	0.446	0.453	0.460	0.467	0.474	0.481	0.488	0.495	0.502	70
80	0.502	0.509	0.516	0.523	0.530	0.537	0.544	0.551	0.558	0.566	0.573	80
90	0.573	0.580	0.587	0.594	0.602	0.609	0.616	0.623	0.631	0.638	0.645	90
100	0.645	0.653	0.660	0.667	0.675	0.682	0.690	0.697	0.704	0.712	0.719	100
110	0.719	0.727	0.734	0.742	0.749	0.757	0.764	0.772	0.780	0.787	0.795	110
120	0.795	0.802	0.810	0.818	0.825	0.833	0.841	0.848	0.856	0.864	0.872	120
130	0.872	0.879	0.887	0.895	0.903	0.910	0.918	0.926	0.934	0.942	0.950	130
140	0.950	0.957	0.965	0.973	0.981	0.989	0.997	1.005	1.013	1.021	1.029	140
150	1.029	1.037	1.045	1.053	1.061	1.069	1.077	1.085	1.093	1.101	1.109	150
160	1.109	1.117	1.125	1.133	1.141	1.149	1.158	1.166	1.174	1.182	1.190	160
170	1.190	1.198	1.207	1.215	1.223	1.231	1.240	1.248	1.256	1.264	1.273	170
180	1.273	1.281	1.289	1.297	1.306	1.314	1.322	1.331	1.339	1.347	1.356	180
190	1.356	1.364	1.373	1.381	1.389	1.398	1.406	1.415	1.423	1.432	1.440	190
200	1.440	1.448	1.457	1.465	1.474	1.482	1.491	1.499	1.508	1.516	1.525	200
210	1.525	1.534	1.542	1.551	1.559	1.568	1.576	1.585	1.594	1.602	1.611	210
220	1.611	1.620	1.628	1.637	1.645	1.654	1.663	1.671	1.680	1.689	1.698	220
230	1.698	1.706	1.715	1.724	1.732	1.741	1.750	1.759	1.767	1.776	1.785	230
240	1.785	1.794	1.802	1.811	1.820	1.829	1.838	1.846	1.855	1.864	1.873	240
250	1.873	1.882	1.891	1.899	1.908	1.917	1.926	1.935	1.944	1.953	1.962	250
260	1.962	1.971	1.979	1.988	1.997	2.006	2.015	2.024	2.033	2.042	2.051	260
270	2.051	2.060	2.069	2.078	2.087	2.096	2.105	2.114	2.123	2.132	2.141	270
280	2.141	2.150	2.159	2.168	2.177	2.186	2.195	2.204	2.213	2.222	2.232	280
290	2.232	2.241	2.250	2.259	2.268	2.277	2.286	2.295	2.304	2.314	2.323	290
300	2.323	2.332	2.341	2.350	2.359	2.368	2.378	2.387	2.396	2.405	2.414	300
310	2.414	2.424	2.433	2.442	2.451	2.460	2.470	2.479	2.488	2.497	2.506	310
320	2.506	2.516	2.525	2.534	2.543	2.553	2.562	2.571	2.581	2.590	2.599	320
330	2.599	2.608	2.618	2.627	2.636	2.646	2.655	2.664	2.674	2.683	2.692	330
340	2.692	2.702	2.711	2.720	2.730	2.739	2.748	2.758	2.767	2.776	2.786	340
350	2.786	2.795	2.805	2.814	2.823	2.833	2.842	2.852	2.861	2.870	2.880	350
360	2.880	2.889	2.899	2.908	2.917	2.927	2.936	2.946	2.955	2.965	2.974	360
370	2.974	2.984	2.993	3.003	3.012	3.022	3.031	3.041	3.050	3.059	3.069	370
380	3.069	3.078	3.088	3.097	3.107	3.117	3.126	3.136	3.145	3.155	3.164	380
390	3.164	3.174	3.183	3.193	3.202	3.212	3.221	3.231	3.241	3.250	3.260	390
400	3.260	3.269	3.279	3.288	3.298	3.308	3.317	3.327	3.336	3.346	3.356	400
410	3.356	3.365	3.375	3.384	3.394	3.404	3.413	3.423	3.433	3.442	3.452	410
420	3.452	3.462	3.471	3.481	3.491	3.500	3.510	3.520	3.529	3.539	3.549	420
430	3.549	3.558	3.568	3.578	3.587	3.597	3.607	3.616	3.626	3.636	3.645	430
440	3.645	3.655	3.665	3.675	3.684	3.694	3.704	3.714	3.723	3.733	3.743	440
450	3.743	3.752	3.762	3.772	3.782	3.791	3.801	3.811	3.821	3.831	3.840	450
460	3.840	3.850	3.860	3.870	3.879	3.889	3.899	3.909	3.919	3.928	3.938	460
470	3.938	3.948	3.958	3.968	3.977	3.987	3.997	4.007	4.017	4.027	4.036	470
480	4.036	4.046	4.056	4.066	4.076	4.086	4.095	4.105	4.115	4.125	4.135	480
490	4.135	4.145	4.155	4.164	4.174	4.184	4.194	4.204	4.214	4.224	4.234	490
500	4.234	4.243	4.253	4.263	4.273	4.283	4.293	4.303	4.313	4.323	4.333	500
510	4.333	4.343	4.352	4.362	4.372	4.382	4.392	4.402	4.412	4.422	4.432	510
520	4.432	4.442	4.452	4.462	4.472	4.482	4.492	4.502	4.512	4.522	4.532	520
530	4.532	4.542	4.552	4.562	4.572	4.582	4.592	4.602	4.612	4.622	4.632	530
540	4.632	4.642	4.652	4.662	4.672	4.682	4.692	4.702	4.712	4.722	4.732	540
550	4.732	4.742	4.752	4.762	4.772	4.782	4.792	4.802	4.812	4.822	4.832	550
560	4.832	4.842	4.852	4.862	4.873	4.883	4.893	4.903	4.913	4.923	4.933	560
570	4.933	4.943	4.953	4.963	4.973	4.984	4.994	5.004	5.014	5.024	5.034	570
580	5.034	5.044	5.054	5.065	5.075	5.085	5.095	5.105	5.115	5.125	5.136	580
590	5.136	5.146	5.156	5.166	5.176	5.186	5.197	5.207	5.217	5.227	5.237	590
600	5.237	5.247	5.258	5.268	5.278	5.288	5.298	5.309	5.319	5.329	5.339	600
610	5.339	5.350	5.360	5.370	5.380	5.391	5.401	5.411	5.421	5.431	5.442	610
620	5.442	5.452	5.462	5.473	5.483	5.493	5.503	5.514	5.524	5.534	5.544	620
630	5.544	5.555	5.565	5.575	5.586	5.596	5.606	5.617	5.627	5.637	5.648	630
640	5.648	5.658	5.668	5.679	5.689	5.700	5.710	5.720	5.731	5.741	5.751	640
650	5.751	5.762	5.772	5.782	5.793	5.803	5.814	5.824	5.834	5.845	5.855	650
660	5.855	5.866	5.876	5.887	5.897	5.907	5.918	5.928	5.939	5.949	5.960	660
670	5.960	5.970	5.980	5.991	6.001	6.012	6.022	6.033	6.043	6.054	6.064	670
680	6.064	6.075	6.085	6.096	6.106	6.117	6.127	6.138	6.148	6.159	6.169	680
690	6.169	6.180	6.190	6.201	6.211	6.222	6.232	6.243	6.253	6.264	6.274	690
700	6.274	6.285	6.295	6.306	6.316	6.327	6.338	6.348	6.359	6.369	6.380	700
710	6.380	6.390	6.401	6.412	6.422	6.433	6.443	6.454	6.465	6.475	6.486	710
720	6.486	6.496	6.507	6.518	6.528	6.539	6.549	6.560	6.571	6.581	6.592	720
730	6.592	6.603	6.613	6.624	6.635	6.645	6.656	6.667	6.677	6.688	6.699	730
740	6.699	6.709	6.720	6.731	6.741	6.752	6.763	6.773	6.784	6.795	6.805	740
750	6.805	6.816	6.827	6.838	6.848	6.859	6.870	6.880	6.891	6.902	6.913	750
760	6.913	6.923	6.934	6.945	6.956	6.966	6.977	6.988	6.999	7.009	7.020	760
770	7.020	7.031	7.042	7.053	7.063	7.074	7.085	7.096	7.107	7.117	7.128	770
780	7.128	7.139	7.150	7.161	7.171	7.182	7.193	7.204	7.215	7.225	7.236	780
790	7.236	7.247	7.258	7.269	7.280	7.291	7.301	7.312	7.323	7.334	7.345	790
800	7.345	7.356	7.367	7.377	7.388	7.399	7.410	7.421	7.432	7.443	7.454	800
810	7.454	7.465	7.476	7.486	7.497	7.508	7.519	7.530	7.541	7.552	7.563	810
820	7.563	7.574	7.585	7.596	7.607	7.618	7.629	7.640	7.651	7.661	7.672	820
830	7.672	7.683	7.694	7.705	7.716	7.727	7.738	7.749	7.760	7.771	7.782	830
840	7.782	7.793	7.804	7.815	7.826	7.837	7.848	7.859	7.870	7.881	7.892	840
850	7.892	7.904	7.915	7.926	7.937	7.948	7.959	7.970	7.981	7.992	8.003	850
860	8.003	8.014	8.025	8.036	8.047	8.058	8.069	8.081	8.092	8.103	8.114	860
870	8.114	8.125	8.136	8.147	8.158	8.169	8.180	8.192	8.203	8.214	8.225	870
880	8.225	8.236	8.247	8.258	8.270	8.281	8.292	8.303	8.314	8.325	8.336	880
890	8.336	8.348	8.359	8.370	8.381	8.392	8.404	8.415	8.426	8.437	8.448	890
DEG C	0	1	2	3	4	5	6	7	8	9	10	DEG C

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TABLE V — Continued

TYPE S

New Reference Tables
Supersedes N.B.S.
Circular #561

Platinum Vs. Platinum-10% Rhodium

Temperature in Degrees C
Reference Junction at 0°C

OMEGA
ENGINEERING, INC.
An OMEGA Group Company
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(203) 359-1660 Telex 996404 Cable OMEGA

THERMOELECTRIC VOLTAGE IN ABSOLUTE MILLIVOLTS

DEG C	0	1	2	3	4	5	6	7	8	9	10	DEG C
900	8.448	8.460	8.471	8.482	8.493	8.504	8.516	8.527	8.538	8.549	8.560	900
910	8.560	8.572	8.583	8.594	8.605	8.617	8.628	8.639	8.650	8.662	8.673	910
920	8.673	8.684	8.695	8.707	8.718	8.729	8.741	8.752	8.763	8.774	8.786	920
930	8.786	8.797	8.808	8.820	8.831	8.842	8.854	8.865	8.876	8.888	8.899	930
940	8.899	8.910	8.922	8.933	8.944	8.956	8.967	8.978	8.990	9.001	9.012	940
950	9.012	9.024	9.035	9.047	9.058	9.069	9.081	9.092	9.103	9.115	9.126	950
960	9.126	9.138	9.149	9.160	9.172	9.183	9.195	9.206	9.217	9.229	9.240	960
970	9.240	9.252	9.263	9.275	9.286	9.298	9.309	9.320	9.332	9.343	9.355	970
980	9.355	9.366	9.378	9.389	9.401	9.412	9.424	9.435	9.447	9.458	9.470	980
990	9.470	9.481	9.493	9.504	9.516	9.527	9.539	9.550	9.562	9.573	9.585	990
1,000	9.585	9.596	9.608	9.619	9.631	9.642	9.654	9.665	9.677	9.689	9.700	1,000
1,010	9.700	9.712	9.723	9.735	9.746	9.758	9.770	9.781	9.793	9.804	9.816	1,010
1,020	9.816	9.828	9.839	9.851	9.862	9.874	9.886	9.897	9.909	9.920	9.932	1,020
1,030	9.932	9.944	9.955	9.967	9.979	9.990	10.002	10.013	10.025	10.037	10.048	1,030
1,040	10.048	10.060	10.072	10.083	10.095	10.107	10.118	10.130	10.142	10.154	10.165	1,040
1,050	10.165	10.177	10.189	10.200	10.212	10.224	10.235	10.247	10.259	10.271	10.282	1,050
1,060	10.282	10.294	10.306	10.318	10.329	10.341	10.353	10.364	10.376	10.388	10.400	1,060
1,070	10.400	10.411	10.423	10.435	10.447	10.459	10.470	10.482	10.494	10.506	10.517	1,070
1,080	10.517	10.529	10.541	10.553	10.565	10.576	10.588	10.600	10.612	10.624	10.635	1,080
1,090	10.635	10.647	10.659	10.671	10.683	10.694	10.706	10.718	10.730	10.742	10.754	1,090
1,100	10.754	10.765	10.777	10.789	10.801	10.813	10.825	10.836	10.848	10.860	10.872	1,100
1,110	10.872	10.884	10.896	10.908	10.919	10.931	10.943	10.955	10.967	10.979	10.991	1,110
1,120	10.991	11.003	11.014	11.026	11.038	11.050	11.062	11.074	11.086	11.098	11.110	1,120
1,130	11.110	11.121	11.133	11.145	11.157	11.169	11.181	11.193	11.205	11.217	11.229	1,130
1,140	11.229	11.241	11.252	11.264	11.276	11.288	11.300	11.312	11.324	11.336	11.348	1,140
1,150	11.348	11.360	11.372	11.384	11.396	11.408	11.420	11.432	11.443	11.455	11.467	1,150
1,160	11.467	11.479	11.491	11.503	11.515	11.527	11.539	11.551	11.563	11.575	11.587	1,160
1,170	11.587	11.599	11.611	11.623	11.635	11.647	11.659	11.671	11.683	11.695	11.707	1,170
1,180	11.707	11.719	11.731	11.743	11.755	11.767	11.779	11.791	11.803	11.815	11.827	1,180
1,190	11.827	11.839	11.851	11.863	11.875	11.887	11.899	11.911	11.923	11.935	11.947	1,190
1,200	11.947	11.959	11.971	11.983	11.995	12.007	12.019	12.031	12.043	12.055	12.067	1,200
1,210	12.067	12.079	12.091	12.103	12.116	12.128	12.140	12.152	12.164	12.176	12.188	1,210
1,220	12.188	12.200	12.212	12.224	12.236	12.248	12.260	12.272	12.284	12.296	12.308	1,220
1,230	12.308	12.320	12.332	12.345	12.357	12.369	12.381	12.393	12.405	12.417	12.429	1,230
1,240	12.429	12.441	12.453	12.465	12.477	12.489	12.501	12.514	12.526	12.538	12.550	1,240
1,250	12.550	12.562	12.574	12.586	12.598	12.610	12.622	12.634	12.647	12.659	12.671	1,250
1,260	12.671	12.683	12.695	12.707	12.719	12.731	12.743	12.755	12.767	12.780	12.792	1,260
1,270	12.792	12.804	12.816	12.828	12.840	12.852	12.864	12.876	12.888	12.901	12.913	1,270
1,280	12.913	12.925	12.937	12.949	12.961	12.973	12.985	12.997	13.010	13.022	13.034	1,280
1,290	13.034	13.046	13.058	13.070	13.082	13.094	13.107	13.119	13.131	13.143	13.155	1,290
1,300	13.155	13.167	13.179	13.191	13.203	13.216	13.228	13.240	13.252	13.264	13.276	1,300
1,310	13.276	13.288	13.300	13.313	13.325	13.337	13.349	13.361	13.373	13.385	13.397	1,310
1,320	13.397	13.410	13.422	13.434	13.446	13.458	13.470	13.482	13.495	13.507	13.519	1,320
1,330	13.519	13.531	13.543	13.555	13.567	13.579	13.592	13.604	13.616	13.628	13.640	1,330
1,340	13.640	13.652	13.664	13.677	13.689	13.701	13.713	13.725	13.737	13.749	13.761	1,340
1,350	13.761	13.774	13.786	13.798	13.810	13.822	13.834	13.846	13.859	13.871	13.883	1,350
1,360	13.883	13.895	13.907	13.919	13.931	13.943	13.956	13.968	13.980	13.992	14.004	1,360
1,370	14.004	14.016	14.028	14.040	14.053	14.065	14.077	14.089	14.101	14.113	14.125	1,370
1,380	14.125	14.138	14.150	14.162	14.174	14.186	14.198	14.210	14.222	14.235	14.247	1,380
1,390	14.247	14.259	14.271	14.283	14.295	14.307	14.319	14.332	14.344	14.356	14.368	1,390
1,400	14.368	14.380	14.392	14.404	14.416	14.429	14.441	14.453	14.465	14.477	14.489	1,400
1,410	14.489	14.501	14.513	14.526	14.538	14.550	14.562	14.574	14.586	14.598	14.610	1,410
1,420	14.610	14.622	14.635	14.647	14.659	14.671	14.683	14.695	14.707	14.719	14.731	1,420
1,430	14.731	14.744	14.756	14.768	14.780	14.792	14.804	14.816	14.828	14.840	14.852	1,430
1,440	14.852	14.865	14.877	14.889	14.901	14.913	14.925	14.937	14.949	14.961	14.973	1,440
1,450	14.973	14.985	14.998	15.010	15.022	15.034	15.046	15.058	15.070	15.082	15.094	1,450
1,460	15.094	15.106	15.118	15.130	15.143	15.155	15.167	15.179	15.191	15.203	15.215	1,460
1,470	15.215	15.227	15.239	15.251	15.263	15.275	15.287	15.299	15.311	15.324	15.336	1,470
1,480	15.336	15.348	15.360	15.372	15.384	15.396	15.408	15.420	15.432	15.444	15.456	1,480
1,490	15.456	15.468	15.480	15.492	15.504	15.516	15.528	15.540	15.552	15.564	15.576	1,490
1,500	15.576	15.589	15.601	15.613	15.625	15.637	15.649	15.661	15.673	15.685	15.697	1,500
1,510	15.697	15.709	15.721	15.733	15.745	15.757	15.769	15.781	15.793	15.805	15.817	1,510
1,520	15.817	15.829	15.841	15.853	15.865	15.877	15.889	15.901	15.913	15.925	15.937	1,520
1,530	15.937	15.949	15.961	15.973	15.985	15.997	16.009	16.021	16.033	16.045	16.057	1,530
1,540	16.057	16.069	16.080	16.092	16.104	16.116	16.128	16.140	16.152	16.164	16.176	1,540
1,550	16.176	16.188	16.200	16.212	16.224	16.236	16.248	16.260	16.272	16.284	16.296	1,550
1,560	16.296	16.308	16.319	16.331	16.343	16.355	16.367	16.379	16.391	16.403	16.415	1,560
1,570	16.415	16.427	16.439	16.451	16.462	16.474	16.486	16.498	16.510	16.522	16.534	1,570
1,580	16.534	16.546	16.558	16.569	16.581	16.593	16.605	16.617	16.629	16.641	16.653	1,580
1,590	16.653	16.664	16.676	16.688	16.700	16.712	16.724	16.736	16.747	16.759	16.771	1,590
1,600	16.771	16.783	16.795	16.807	16.819	16.830	16.842	16.854	16.866	16.878	16.890	1,600
1,610	16.890	16.901	16.913	16.925	16.937	16.949	16.960	16.972	16.984	16.996	17.008	1,610
1,620	17.008	17.019	17.031	17.043	17.055	17.067	17.078	17.090	17.102	17.114	17.125	1,620
1,630	17.125	17.137	17.149	17.161	17.173	17.184	17.196	17.208	17.220	17.231	17.243	1,630
1,640	17.243	17.255	17.267	17.278	17.290	17.302	17.313	17.325	17.337	17.349	17.360	1,640
1,650	17.360	17.372	17.384	17.396	17.407	17.419	17.431	17.442	17.454	17.466	17.477	1,650
1,660	17.477	17.489	17.501	17.512	17.524	17.536	17.548	17.559	17.571	17.583	17.594	1,660
1,670	17.594	17.606	17.617	17.629	17.641	17.652	17.664	17.676	17.687	17.699	17.711	1,670
1,680	17.711	17.722	17.734	17.745	17.757	17.769	17.780	17.792	17.803	17.815	17.826	1,680
1,690	17.826	17.838	17.850	17.861	17.873	17.884	17.896	17.907	17.919	17.930	17.942	1,690
1,700	17.942	17.953	17.965	17.976	17.988	17.999	18.010	18.022	18.033	18.045	18.056	1,700
1,710	18.056	18.068	18.079	18.090	18.102	18.113	18.124	18.136	18.147	18.158	18.170	1,710
1,720	18.170	18.181	18.192	18.204	18.215	18.226	18.237	18.249	18.260	18.271	18.282	1,720
1,730	18.282	18.293	18.305	18.316	18.327	18.338	18.349	18.360	18.372	18.383	18.394	1,730
1,740	18.394	18.405	18.416	18.427	18.438	18.449	18.460	18.471	18.482	18.493	18.504	1,740
1,750	18.504	18.515	18.526	18.536	18.547	18.558	18.569	18.580	18.591	18.602	18.612	1,750
1,760	18.612	18.623	18.634	18.645	18.655	18.666	18.677	18.687	18.698			1,760
DEG C	0	1	2	3	4	5	6	7	8	9	10	DEG C

TABLE VI

TYPE R

New Reference Tables
Supersedes N.B.S.
Circular #561

Platinum Vs. Platinum-13% Rhodium

Temperature in Degrees C
Reference Junction at 0°C

THERMOELECTRIC VOLTAGE IN ABSOLUTE MILLIVOLTS

DEG C	0	1	2	3	4	5	6	7	8	9	10	DEG C
0	0.000	0.005	0.011	0.016	0.021	0.027	0.032	0.038	0.043	0.049	0.054	0
10	0.054	0.060	0.065	0.071	0.077	0.082	0.088	0.094	0.100	0.105	0.111	10
20	0.111	0.117	0.123	0.129	0.135	0.141	0.147	0.152	0.158	0.165	0.171	20
30	0.171	0.177	0.183	0.189	0.195	0.201	0.207	0.214	0.220	0.226	0.232	30
40	0.232	0.239	0.245	0.251	0.258	0.264	0.271	0.277	0.283	0.290	0.296	40
50	0.296	0.303	0.310	0.316	0.323	0.329	0.336	0.343	0.349	0.356	0.363	50
60	0.363	0.369	0.376	0.383	0.390	0.397	0.403	0.410	0.417	0.424	0.431	60
70	0.431	0.438	0.445	0.452	0.459	0.466	0.473	0.480	0.487	0.494	0.501	70
80	0.501	0.508	0.515	0.523	0.530	0.537	0.544	0.552	0.559	0.566	0.573	80
90	0.573	0.581	0.588	0.595	0.603	0.610	0.617	0.625	0.632	0.640	0.647	90
100	0.647	0.655	0.662	0.670	0.677	0.685	0.692	0.700	0.708	0.715	0.723	100
110	0.723	0.730	0.738	0.746	0.754	0.761	0.769	0.777	0.784	0.792	0.800	110
120	0.800	0.808	0.816	0.824	0.831	0.839	0.847	0.855	0.863	0.871	0.879	120
130	0.879	0.887	0.895	0.903	0.911	0.919	0.927	0.935	0.943	0.951	0.959	130
140	0.959	0.967	0.975	0.983	0.992	1.000	1.008	1.016	1.024	1.032	1.041	140
150	1.041	1.049	1.057	1.065	1.074	1.082	1.090	1.099	1.107	1.115	1.124	150
160	1.124	1.132	1.140	1.149	1.157	1.166	1.174	1.183	1.191	1.200	1.208	160
170	1.208	1.217	1.225	1.234	1.242	1.251	1.259	1.268	1.276	1.285	1.294	170
180	1.294	1.302	1.311	1.319	1.328	1.337	1.345	1.354	1.363	1.372	1.380	180
190	1.380	1.389	1.398	1.407	1.415	1.424	1.433	1.442	1.450	1.459	1.468	190
200	1.468	1.477	1.486	1.495	1.504	1.512	1.521	1.530	1.539	1.548	1.557	200
210	1.557	1.566	1.575	1.584	1.593	1.602	1.611	1.620	1.629	1.638	1.647	210
220	1.647	1.656	1.665	1.674	1.683	1.692	1.702	1.711	1.720	1.729	1.738	220
230	1.738	1.747	1.756	1.766	1.775	1.784	1.793	1.802	1.812	1.821	1.830	230
240	1.830	1.839	1.849	1.858	1.867	1.876	1.886	1.895	1.904	1.914	1.923	240
250	1.923	1.932	1.942	1.951	1.960	1.970	1.979	1.988	1.998	2.007	2.017	250
260	2.017	2.026	2.036	2.045	2.054	2.064	2.073	2.083	2.092	2.102	2.111	260
270	2.111	2.121	2.130	2.140	2.149	2.159	2.169	2.178	2.188	2.197	2.207	270
280	2.207	2.216	2.226	2.236	2.245	2.255	2.264	2.274	2.284	2.293	2.303	280
290	2.303	2.313	2.322	2.332	2.342	2.351	2.361	2.371	2.381	2.390	2.400	290
300	2.400	2.410	2.420	2.429	2.439	2.449	2.459	2.468	2.478	2.488	2.498	300
310	2.498	2.508	2.517	2.527	2.537	2.547	2.557	2.567	2.577	2.586	2.596	310
320	2.596	2.606	2.616	2.626	2.636	2.646	2.656	2.666	2.676	2.685	2.695	320
330	2.695	2.705	2.715	2.725	2.735	2.745	2.755	2.765	2.775	2.785	2.795	330
340	2.795	2.805	2.815	2.825	2.835	2.845	2.855	2.866	2.876	2.886	2.896	340
350	2.896	2.906	2.916	2.926	2.936	2.946	2.956	2.966	2.977	2.987	2.997	350
360	2.997	3.007	3.017	3.027	3.037	3.048	3.058	3.068	3.078	3.088	3.099	360
370	3.099	3.109	3.119	3.129	3.139	3.150	3.160	3.170	3.180	3.191	3.201	370
380	3.201	3.211	3.221	3.232	3.242	3.252	3.263	3.273	3.283	3.293	3.304	380
390	3.304	3.314	3.324	3.335	3.345	3.355	3.366	3.376	3.386	3.397	3.407	390
400	3.407	3.418	3.428	3.438	3.449	3.459	3.470	3.480	3.490	3.501	3.511	400
410	3.511	3.522	3.532	3.543	3.553	3.563	3.574	3.584	3.595	3.605	3.616	410
420	3.616	3.626	3.637	3.647	3.658	3.668	3.679	3.689	3.700	3.710	3.721	420
430	3.721	3.731	3.742	3.752	3.763	3.774	3.784	3.795	3.805	3.816	3.826	430
440	3.826	3.837	3.848	3.858	3.869	3.879	3.890	3.901	3.911	3.922	3.933	440
450	3.933	3.943	3.954	3.964	3.975	3.986	3.996	4.007	4.018	4.028	4.039	450
460	4.039	4.050	4.061	4.071	4.082	4.093	4.103	4.114	4.125	4.136	4.146	460
470	4.146	4.157	4.168	4.178	4.189	4.200	4.211	4.222	4.232	4.243	4.254	470
480	4.254	4.265	4.275	4.286	4.297	4.308	4.319	4.329	4.340	4.351	4.362	480
490	4.362	4.373	4.384	4.394	4.405	4.416	4.427	4.438	4.449	4.460	4.471	490
500	4.471	4.481	4.492	4.503	4.514	4.525	4.536	4.547	4.558	4.569	4.580	500
510	4.580	4.591	4.601	4.612	4.623	4.634	4.645	4.656	4.667	4.678	4.689	510
520	4.689	4.700	4.711	4.722	4.733	4.744	4.755	4.766	4.777	4.788	4.799	520
530	4.799	4.810	4.821	4.832	4.843	4.854	4.865	4.876	4.888	4.899	4.910	530
540	4.910	4.921	4.932	4.943	4.954	4.965	4.976	4.987	4.998	5.009	5.021	540
550	5.021	5.032	5.043	5.054	5.065	5.076	5.087	5.099	5.110	5.121	5.132	550
560	5.132	5.143	5.154	5.166	5.177	5.188	5.199	5.210	5.221	5.233	5.244	560
570	5.244	5.255	5.266	5.278	5.289	5.300	5.311	5.322	5.334	5.345	5.356	570
580	5.356	5.368	5.379	5.390	5.401	5.413	5.424	5.435	5.446	5.458	5.469	580
590	5.469	5.480	5.492	5.503	5.514	5.526	5.537	5.548	5.560	5.571	5.582	590
600	5.582	5.594	5.605	5.616	5.628	5.639	5.650	5.662	5.673	5.685	5.696	600
610	5.696	5.707	5.719	5.730	5.742	5.753	5.764	5.776	5.787	5.799	5.810	610
620	5.810	5.821	5.833	5.844	5.856	5.867	5.879	5.890	5.902	5.913	5.925	620
630	5.925	5.936	5.948	5.959	5.971	5.982	5.994	6.005	6.017	6.028	6.040	630
640	6.040	6.051	6.063	6.074	6.086	6.098	6.109	6.121	6.132	6.144	6.155	640
650	6.155	6.167	6.179	6.190	6.202	6.213	6.225	6.237	6.248	6.260	6.272	650
660	6.272	6.283	6.295	6.307	6.318	6.330	6.342	6.353	6.365	6.377	6.388	660
670	6.388	6.400	6.412	6.423	6.435	6.447	6.458	6.470	6.482	6.494	6.505	670
680	6.505	6.517	6.529	6.541	6.552	6.564	6.576	6.588	6.599	6.611	6.623	680
690	6.623	6.635	6.647	6.658	6.670	6.682	6.694	6.706	6.718	6.729	6.741	690
700	6.741	6.753	6.765	6.777	6.789	6.800	6.812	6.824	6.836	6.848	6.860	700
710	6.860	6.872	6.884	6.895	6.907	6.919	6.931	6.943	6.955	6.967	6.979	710
720	6.979	6.991	7.003	7.015	7.027	7.039	7.051	7.063	7.074	7.086	7.098	720
730	7.098	7.110	7.122	7.134	7.146	7.158	7.170	7.182	7.194	7.206	7.218	730
740	7.218	7.231	7.243	7.255	7.267	7.279	7.291	7.303	7.315	7.327	7.339	740
750	7.339	7.351	7.363	7.375	7.387	7.399	7.412	7.424	7.436	7.448	7.460	750
760	7.460	7.472	7.484	7.496	7.509	7.521	7.533	7.545	7.557	7.569	7.582	760
770	7.582	7.594	7.606	7.618	7.630	7.642	7.655	7.667	7.679	7.691	7.703	770
780	7.703	7.716	7.728	7.740	7.752	7.765	7.777	7.789	7.801	7.814	7.826	780
790	7.826	7.838	7.850	7.863	7.875	7.887	7.900	7.912	7.924	7.937	7.949	790
800	7.949	7.961	7.973	7.986	7.998	8.010	8.023	8.035	8.047	8.060	8.072	800
810	8.072	8.085	8.097	8.109	8.122	8.134	8.146	8.159	8.171	8.184	8.196	810
820	8.196	8.208	8.221	8.233	8.246	8.258	8.271	8.283	8.295	8.308	8.320	820
830	8.320	8.333	8.345	8.358	8.370	8.383	8.395	8.408	8.420	8.433	8.445	830
840	8.445	8.458	8.470	8.483	8.495	8.508	8.520	8.533	8.545	8.558	8.570	840
850	8.570	8.583	8.595	8.608	8.621	8.633	8.646	8.658	8.671	8.683	8.696	850
860	8.696	8.709	8.721	8.734	8.746	8.759	8.772	8.784	8.797	8.810	8.822	860
870	8.822	8.835	8.847	8.860	8.873	8.885	8.898	8.911	8.923	8.936	8.949	870
880	8.949	8.961	8.974	8.987	9.000	9.012	9.025	9.038	9.050	9.063	9.076	880
890	9.076	9.089	9.101	9.114	9.127	9.140	9.152	9.165	9.178	9.191	9.203	890
DEG C	0	1	2	3	4	5	6	7	8	9	10	DEG C

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TABLE VI — Continued

TYPE R

New Reference Tables
Supersedes N.B.S.
Circular #561

Platinum Vs. Platinum-13% Rhodium

Temperature in Degrees C
Reference Junction at 0°C

THERMOELECTRIC VOLTAGE IN ABSOLUTE MILLIVOLTS

DEG C	0	1	2	3	4	5	6	7	8	9	10	DEG C
900	9.203	9.216	9.229	9.242	9.254	9.267	9.280	9.293	9.306	9.319	9.331	900
910	9.331	9.344	9.357	9.370	9.383	9.395	9.408	9.421	9.434	9.447	9.460	910
920	9.460	9.473	9.485	9.498	9.511	9.524	9.537	9.550	9.563	9.576	9.589	920
930	9.589	9.602	9.614	9.627	9.640	9.653	9.666	9.679	9.692	9.705	9.718	930
940	9.718	9.731	9.744	9.757	9.770	9.783	9.796	9.809	9.822	9.835	9.848	940
950	9.848	9.861	9.874	9.887	9.900	9.913	9.926	9.939	9.952	9.965	9.978	950
960	9.978	9.991	10.004	10.017	10.030	10.043	10.056	10.069	10.082	10.095	10.109	960
970	10.109	10.122	10.135	10.148	10.161	10.174	10.187	10.200	10.213	10.227	10.240	970
980	10.240	10.253	10.266	10.279	10.292	10.305	10.319	10.332	10.345	10.358	10.371	980
990	10.371	10.384	10.398	10.411	10.424	10.437	10.450	10.464	10.477	10.490	10.503	990
1,000	10.503	10.516	10.530	10.543	10.556	10.569	10.583	10.596	10.609	10.622	10.636	1,000
1,010	10.636	10.649	10.662	10.675	10.689	10.702	10.715	10.729	10.742	10.755	10.768	1,010
1,020	10.768	10.782	10.795	10.808	10.822	10.835	10.848	10.862	10.875	10.888	10.902	1,020
1,030	10.902	10.915	10.928	10.942	10.955	10.968	10.982	10.995	11.009	11.022	11.035	1,030
1,040	11.035	11.049	11.062	11.076	11.089	11.102	11.116	11.129	11.143	11.156	11.170	1,040
1,050	11.170	11.183	11.196	11.210	11.223	11.237	11.250	11.264	11.277	11.291	11.304	1,050
1,060	11.304	11.318	11.331	11.345	11.358	11.372	11.385	11.399	11.412	11.426	11.439	1,060
1,070	11.439	11.453	11.466	11.480	11.493	11.507	11.520	11.534	11.547	11.561	11.574	1,070
1,080	11.574	11.588	11.602	11.615	11.629	11.642	11.656	11.669	11.683	11.697	11.710	1,080
1,090	11.710	11.724	11.737	11.751	11.765	11.778	11.792	11.805	11.819	11.833	11.846	1,090
1,100	11.846	11.860	11.874	11.887	11.901	11.914	11.928	11.942	11.955	11.969	11.983	1,100
1,110	11.983	11.996	12.010	12.024	12.037	12.051	12.065	12.078	12.092	12.106	12.119	1,110
1,120	12.119	12.133	12.147	12.161	12.174	12.188	12.202	12.215	12.229	12.243	12.257	1,120
1,130	12.257	12.270	12.284	12.298	12.311	12.325	12.339	12.353	12.366	12.380	12.394	1,130
1,140	12.394	12.408	12.421	12.435	12.449	12.463	12.476	12.490	12.504	12.518	12.532	1,140
1,150	12.532	12.545	12.559	12.573	12.587	12.600	12.614	12.628	12.642	12.656	12.669	1,150
1,160	12.669	12.683	12.697	12.711	12.725	12.739	12.752	12.766	12.780	12.794	12.808	1,160
1,170	12.808	12.822	12.835	12.849	12.863	12.877	12.891	12.905	12.918	12.932	12.946	1,170
1,180	12.946	12.960	12.974	12.988	13.002	13.016	13.029	13.043	13.057	13.071	13.085	1,180
1,190	13.085	13.099	13.113	13.127	13.140	13.154	13.168	13.182	13.196	13.210	13.224	1,190
1,200	13.224	13.238	13.252	13.266	13.280	13.293	13.307	13.321	13.335	13.349	13.363	1,200
1,210	13.363	13.377	13.391	13.405	13.419	13.433	13.447	13.461	13.475	13.489	13.502	1,210
1,220	13.502	13.516	13.530	13.544	13.558	13.572	13.586	13.600	13.614	13.628	13.642	1,220
1,230	13.642	13.656	13.670	13.684	13.698	13.712	13.726	13.740	13.754	13.768	13.782	1,230
1,240	13.782	13.796	13.810	13.824	13.838	13.852	13.866	13.880	13.894	13.908	13.922	1,240
1,250	13.922	13.936	13.950	13.964	13.978	13.992	14.006	14.020	14.034	14.048	14.062	1,250
1,260	14.062	14.076	14.090	14.104	14.118	14.132	14.146	14.160	14.174	14.188	14.202	1,260
1,270	14.202	14.216	14.230	14.244	14.258	14.272	14.286	14.301	14.315	14.329	14.343	1,270
1,280	14.343	14.357	14.371	14.385	14.399	14.413	14.427	14.441	14.455	14.469	14.483	1,280
1,290	14.483	14.497	14.511	14.525	14.539	14.554	14.568	14.582	14.596	14.610	14.624	1,290
1,300	14.624	14.638	14.652	14.666	14.680	14.694	14.708	14.722	14.737	14.751	14.765	1,300
1,310	14.765	14.779	14.793	14.807	14.821	14.835	14.849	14.863	14.877	14.891	14.906	1,310
1,320	14.906	14.920	14.934	14.948	14.962	14.976	14.990	15.004	15.018	15.032	15.047	1,320
1,330	15.047	15.061	15.075	15.089	15.103	15.117	15.131	15.145	15.159	15.173	15.188	1,330
1,340	15.188	15.202	15.216	15.230	15.244	15.258	15.272	15.286	15.300	15.315	15.329	1,340
1,350	15.329	15.343	15.357	15.371	15.385	15.399	15.413	15.427	15.442	15.456	15.470	1,350
1,360	15.470	15.484	15.498	15.512	15.526	15.540	15.555	15.569	15.583	15.597	15.611	1,360
1,370	15.611	15.625	15.639	15.653	15.667	15.682	15.696	15.710	15.724	15.738	15.752	1,370
1,380	15.752	15.766	15.780	15.795	15.809	15.823	15.837	15.851	15.865	15.879	15.893	1,380
1,390	15.893	15.908	15.922	15.936	15.950	15.964	15.978	15.992	16.006	16.021	16.035	1,390
1,400	16.035	16.049	16.063	16.077	16.091	16.105	16.119	16.134	16.148	16.162	16.176	1,400
1,410	16.176	16.190	16.204	16.218	16.232	16.247	16.261	16.275	16.289	16.303	16.317	1,410
1,420	16.317	16.331	16.345	16.360	16.374	16.388	16.402	16.416	16.430	16.444	16.458	1,420
1,430	16.458	16.472	16.487	16.501	16.515	16.529	16.543	16.557	16.571	16.585	16.599	1,430
1,440	16.599	16.614	16.628	16.642	16.656	16.670	16.684	16.698	16.712	16.726	16.741	1,440
1,450	16.741	16.755	16.769	16.783	16.797	16.811	16.825	16.839	16.853	16.867	16.882	1,450
1,460	16.882	16.896	16.910	16.924	16.938	16.952	16.966	16.980	16.994	17.008	17.022	1,460
1,470	17.022	17.037	17.051	17.065	17.079	17.093	17.107	17.121	17.135	17.149	17.163	1,470
1,480	17.163	17.177	17.192	17.206	17.220	17.234	17.248	17.262	17.276	17.290	17.304	1,480
1,490	17.304	17.318	17.332	17.346	17.360	17.374	17.388	17.403	17.417	17.431	17.445	1,490
1,500	17.445	17.459	17.473	17.487	17.501	17.515	17.529	17.543	17.557	17.571	17.585	1,500
1,510	17.585	17.599	17.613	17.627	17.641	17.655	17.669	17.684	17.698	17.712	17.726	1,510
1,520	17.726	17.740	17.754	17.768	17.782	17.796	17.810	17.824	17.838	17.852	17.866	1,520
1,530	17.866	17.880	17.894	17.908	17.922	17.936	17.950	17.964	17.978	17.992	18.006	1,530
1,540	18.006	18.020	18.034	18.048	18.062	18.076	18.090	18.104	18.118	18.132	18.146	1,540
1,550	18.146	18.160	18.174	18.188	18.202	18.216	18.230	18.244	18.258	18.272	18.286	1,550
1,560	18.286	18.299	18.313	18.327	18.341	18.355	18.369	18.383	18.397	18.411	18.425	1,560
1,570	18.425	18.439	18.453	18.467	18.481	18.495	18.509	18.523	18.537	18.550	18.564	1,570
1,580	18.564	18.578	18.592	18.606	18.620	18.634	18.648	18.662	18.676	18.690	18.703	1,580
1,590	18.703	18.717	18.731	18.745	18.759	18.773	18.787	18.801	18.815	18.828	18.842	1,590
1,600	18.842	18.856	18.870	18.884	18.898	18.912	18.926	18.939	18.953	18.967	18.981	1,600
1,610	18.981	18.995	19.009	19.023	19.036	19.050	19.064	19.078	19.092	19.106	19.119	1,610
1,620	19.119	19.133	19.147	19.161	19.175	19.188	19.202	19.216	19.230	19.244	19.257	1,620
1,630	19.257	19.271	19.285	19.299	19.313	19.326	19.340	19.354	19.368	19.382	19.395	1,630
1,640	19.395	19.409	19.423	19.437	19.450	19.464	19.478	19.492	19.505	19.519	19.533	1,640
1,650	19.533	19.547	19.560	19.574	19.588	19.602	19.615	19.629	19.643	19.656	19.670	1,650
1,660	19.670	19.684	19.698	19.711	19.725	19.739	19.752	19.766	19.780	19.793	19.807	1,660
1,670	19.807	19.821	19.834	19.848	19.862	19.875	19.889	19.903	19.916	19.930	19.944	1,670
1,680	19.944	19.957	19.971	19.985	19.998	20.012	20.025	20.039	20.053	20.066	20.080	1,680
1,690	20.080	20.093	20.107	20.120	20.134	20.148	20.161	20.175	20.188	20.202	20.215	1,690
1,700	20.215	20.229	20.242	20.256	20.269	20.283	20.296	20.309	20.323	20.336	20.350	1,700
1,710	20.350	20.363	20.377	20.390	20.403	20.417	20.430	20.443	20.457	20.470	20.483	1,710
1,720	20.483	20.497	20.510	20.523	20.537	20.550	20.563	20.576	20.590	20.603	20.616	1,720
1,730	20.616	20.629	20.642	20.656	20.669	20.682	20.695	20.708	20.721	20.734	20.748	1,730
1,740	20.748	20.761	20.774	20.787	20.800	20.813	20.826	20.839	20.852	20.865	20.878	1,740
1,750	20.878	20.891	20.904	20.916	20.929	20.942	20.955	20.968	20.981	20.994	21.006	1,750
1,760	21.006	21.019	21.032	21.045	21.057	21.070	21.083	21.096	21.108			1,760
DEG C	0	1	2	3	4	5	6	7	8	9	10	DEG C

OMEGA ENGINEERING, INC.
An OMEGA Group Company

One Omega Drive, Box 4047, Stamford, CT 06907
(203) 359-1660 Telex 996404 Cable OMEGA

TABLE VII

TYPE B

New Reference Tables
Supersedes N.B.S.
Circular #561

Platinum-6% Rhodium Vs. Platinum-30% Rhodium

Temperature in Degrees C
Reference Junction at 0°C

THERMOELECTRIC VOLTAGE IN ABSOLUTE MILLIVOLTS

DEG C	0	1	2	3	4	5	6	7	8	9	10	DEG C
0	0.000	-0.000	-0.000	-0.001	-0.001	-0.001	-0.001	-0.001	-0.002	-0.002	-0.002	0
10	-0.002	-0.002	-0.002	-0.002	-0.002	-0.002	-0.002	-0.002	-0.003	-0.003	-0.003	10
20	-0.003	-0.003	-0.003	-0.003	-0.003	-0.002	-0.002	-0.002	-0.002	-0.002	-0.002	20
30	-0.002	-0.002	-0.002	-0.002	-0.002	-0.001	-0.001	-0.001	-0.001	-0.001	-0.000	30
40	-0.000	-0.000	-0.000	0.000	0.000	0.001	0.001	0.001	0.002	0.002	0.002	40
50	0.002	0.003	0.003	0.003	0.004	0.004	0.004	0.005	0.005	0.006	0.006	50
60	0.006	0.007	0.007	0.008	0.008	0.009	0.009	0.010	0.010	0.011	0.011	60
70	0.011	0.012	0.012	0.013	0.014	0.014	0.015	0.015	0.016	0.017	0.017	70
80	0.017	0.018	0.019	0.020	0.020	0.021	0.022	0.022	0.023	0.024	0.025	80
90	0.025	0.026	0.026	0.027	0.028	0.029	0.030	0.031	0.031	0.032	0.033	90
100	0.033	0.034	0.035	0.036	0.037	0.038	0.039	0.040	0.041	0.042	0.043	100
110	0.043	0.044	0.045	0.046	0.047	0.048	0.049	0.050	0.051	0.052	0.053	110
120	0.053	0.055	0.056	0.057	0.058	0.059	0.060	0.062	0.063	0.064	0.065	120
130	0.065	0.066	0.068	0.069	0.070	0.071	0.073	0.074	0.075	0.077	0.078	130
140	0.078	0.079	0.081	0.082	0.083	0.085	0.086	0.088	0.089	0.091	0.092	140
150	0.092	0.093	0.095	0.096	0.098	0.099	0.101	0.102	0.104	0.106	0.107	150
160	0.107	0.109	0.110	0.112	0.113	0.115	0.117	0.118	0.120	0.122	0.123	160
170	0.123	0.125	0.127	0.128	0.130	0.132	0.133	0.135	0.137	0.139	0.140	170
180	0.140	0.142	0.144	0.146	0.148	0.149	0.151	0.153	0.155	0.157	0.159	180
190	0.159	0.161	0.163	0.164	0.166	0.168	0.170	0.172	0.174	0.176	0.178	190
200	0.178	0.180	0.182	0.184	0.186	0.188	0.190	0.192	0.194	0.197	0.199	200
210	0.199	0.201	0.203	0.205	0.207	0.209	0.211	0.214	0.216	0.218	0.220	210
220	0.220	0.222	0.225	0.227	0.229	0.231	0.234	0.236	0.238	0.240	0.243	220
230	0.243	0.245	0.247	0.250	0.252	0.254	0.257	0.259	0.262	0.264	0.266	230
240	0.266	0.269	0.271	0.274	0.276	0.279	0.281	0.284	0.286	0.289	0.291	240
250	0.291	0.294	0.296	0.299	0.301	0.304	0.307	0.309	0.312	0.314	0.317	250
260	0.317	0.320	0.322	0.325	0.328	0.330	0.333	0.336	0.338	0.341	0.344	260
260	0.317	0.320	0.322	0.325	0.328	0.330	0.333	0.336	0.338	0.341	0.344	260
270	0.344	0.347	0.349	0.352	0.355	0.358	0.360	0.363	0.366	0.369	0.372	270
280	0.372	0.375	0.377	0.380	0.383	0.386	0.389	0.392	0.395	0.398	0.401	280
290	0.401	0.404	0.406	0.409	0.412	0.415	0.418	0.421	0.424	0.427	0.431	290
300	0.431	0.434	0.437	0.440	0.443	0.446	0.449	0.452	0.455	0.458	0.462	300
310	0.462	0.465	0.468	0.471	0.474	0.477	0.481	0.484	0.487	0.490	0.494	310
320	0.494	0.497	0.500	0.503	0.507	0.510	0.513	0.517	0.520	0.523	0.527	320
330	0.527	0.530	0.533	0.537	0.540	0.544	0.547	0.550	0.554	0.557	0.561	330
340	0.561	0.564	0.568	0.571	0.575	0.578	0.582	0.585	0.589	0.592	0.596	340
350	0.596	0.599	0.603	0.606	0.610	0.614	0.617	0.621	0.625	0.628	0.632	350
360	0.632	0.636	0.639	0.643	0.647	0.650	0.654	0.658	0.661	0.665	0.669	360
370	0.669	0.673	0.677	0.680	0.684	0.688	0.692	0.696	0.699	0.703	0.707	370
380	0.707	0.711	0.715	0.719	0.723	0.727	0.730	0.734	0.738	0.742	0.746	380
390	0.746	0.750	0.754	0.758	0.762	0.766	0.770	0.774	0.778	0.782	0.786	390
400	0.786	0.790	0.794	0.799	0.803	0.807	0.811	0.815	0.819	0.823	0.827	400
410	0.827	0.832	0.836	0.840	0.844	0.848	0.853	0.857	0.861	0.865	0.870	410
420	0.870	0.874	0.878	0.882	0.887	0.891	0.895	0.900	0.904	0.908	0.913	420
430	0.913	0.917	0.921	0.926	0.930	0.935	0.939	0.943	0.948	0.952	0.957	430
440	0.957	0.961	0.966	0.970	0.975	0.979	0.984	0.988	0.993	0.997	1.002	440
450	1.002	1.006	1.011	1.015	1.020	1.025	1.029	1.034	1.039	1.043	1.048	450
460	1.048	1.052	1.057	1.062	1.066	1.071	1.076	1.081	1.085	1.090	1.095	460
470	1.095	1.100	1.104	1.109	1.114	1.119	1.123	1.128	1.133	1.138	1.143	470
480	1.143	1.148	1.152	1.157	1.162	1.167	1.172	1.177	1.182	1.187	1.192	480
490	1.192	1.197	1.202	1.206	1.211	1.216	1.221	1.226	1.231	1.236	1.241	490
500	1.241	1.246	1.252	1.257	1.262	1.267	1.272	1.277	1.282	1.287	1.292	500
510	1.292	1.297	1.303	1.308	1.313	1.318	1.323	1.328	1.334	1.339	1.344	510
520	1.344	1.349	1.354	1.360	1.365	1.370	1.375	1.381	1.386	1.391	1.397	520
530	1.397	1.402	1.407	1.413	1.418	1.423	1.429	1.434	1.439	1.445	1.450	530
540	1.450	1.456	1.461	1.467	1.472	1.477	1.483	1.488	1.494	1.499	1.505	540
550	1.505	1.510	1.516	1.521	1.527	1.532	1.538	1.544	1.549	1.555	1.560	550
560	1.560	1.566	1.571	1.577	1.583	1.588	1.594	1.600	1.605	1.611	1.617	560
570	1.617	1.622	1.628	1.634	1.639	1.645	1.651	1.657	1.662	1.668	1.674	570
580	1.674	1.680	1.685	1.691	1.697	1.703	1.709	1.715	1.720	1.726	1.732	580
590	1.732	1.738	1.744	1.750	1.756	1.762	1.767	1.773	1.779	1.785	1.791	590
600	1.791	1.797	1.803	1.809	1.815	1.821	1.827	1.833	1.839	1.845	1.851	600
610	1.851	1.857	1.863	1.869	1.875	1.882	1.888	1.894	1.900	1.906	1.912	610
620	1.912	1.918	1.924	1.931	1.937	1.943	1.949	1.955	1.961	1.968	1.974	620
630	1.974	1.980	1.986	1.993	1.999	2.005	2.011	2.018	2.024	2.030	2.036	630
640	2.036	2.043	2.049	2.055	2.062	2.068	2.074	2.081	2.087	2.094	2.100	640
650	2.100	2.106	2.113	2.119	2.126	2.132	2.139	2.145	2.151	2.158	2.164	650
660	2.164	2.171	2.177	2.184	2.190	2.197	2.203	2.210	2.216	2.223	2.230	660
670	2.230	2.236	2.243	2.249	2.256	2.263	2.269	2.276	2.282	2.289	2.296	670
680	2.296	2.302	2.309	2.316	2.322	2.329	2.336	2.343	2.349	2.356	2.363	680
690	2.363	2.369	2.376	2.383	2.390	2.396	2.403	2.410	2.417	2.424	2.430	690
700	2.430	2.437	2.444	2.451	2.458	2.465	2.472	2.478	2.485	2.492	2.499	700
710	2.499	2.506	2.513	2.520	2.527	2.534	2.541	2.548	2.555	2.562	2.569	710
720	2.569	2.576	2.583	2.590	2.597	2.604	2.611	2.618	2.625	2.632	2.639	720
730	2.639	2.646	2.653	2.660	2.667	2.674	2.682	2.689	2.696	2.703	2.710	730
740	2.710	2.717	2.724	2.732	2.739	2.746	2.753	2.760	2.768	2.775	2.782	740
750	2.782	2.789	2.797	2.804	2.811	2.818	2.826	2.833	2.840	2.848	2.855	750
760	2.855	2.862	2.869	2.877	2.884	2.892	2.899	2.906	2.914	2.921	2.928	760
770	2.928	2.936	2.943	2.951	2.958	2.966	2.973	2.980	2.988	2.995	3.003	770
780	3.003	3.010	3.018	3.025	3.033	3.040	3.048	3.055	3.063	3.070	3.078	780
790	3.078	3.086	3.093	3.101	3.108	3.116	3.124	3.131	3.139	3.146	3.154	790
800	3.154	3.162	3.169	3.177	3.185	3.192	3.200	3.208	3.215	3.223	3.231	800
810	3.231	3.239	3.246	3.254	3.262	3.269	3.277	3.285	3.293	3.301	3.308	810
820	3.308	3.316	3.324	3.332	3.340	3.347	3.355	3.363	3.371	3.379	3.387	820
830	3.387	3.395	3.402	3.410	3.418	3.426	3.434	3.442	3.450	3.458	3.466	830
840	3.466	3.474	3.482	3.490	3.498	3.506	3.514	3.522	3.530	3.538	3.546	840
850	3.546	3.554	3.562	3.570	3.578	3.586	3.594	3.602	3.610	3.618	3.626	850
860	3.626	3.634	3.643	3.651	3.659	3.667	3.675	3.683	3.691	3.700	3.708	860
870	3.708	3.716	3.724	3.732	3.741	3.749	3.757	3.765	3.773	3.782	3.790	870
880	3.790	3.798	3.806	3.815	3.823	3.831	3.840	3.848	3.856	3.865	3.873	880
890	3.873	3.881	3.890	3.898	3.906	3.915	3.923	3.931	3.940	3.948	3.957	890
DEG C	0	1	2	3	4	5	6	7	8	9	10	DEG C

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TABLE VII — Continued

TYPE B

New Reference Tables
Supersedes N.B.S.
Circular #561

Platinum-6% Rhodium Vs. Platinum-30% Rhodium

Temperature in Degrees C
Reference Junction at 0°C

THERMOELECTRIC VOLTAGE IN ABSOLUTE MILLIVOLTS

DEG C	0	1	2	3	4	5	6	7	8	9	10	DEG C
900	3.957	3.965	3.973	3.982	3.990	3.999	4.007	4.016	4.024	4.032	4.041	900
910	4.041	4.049	4.058	4.066	4.075	4.083	4.092	4.100	4.109	4.117	4.126	910
920	4.126	4.135	4.143	4.152	4.160	4.169	4.177	4.186	4.195	4.203	4.212	920
930	4.212	4.220	4.229	4.238	4.246	4.255	4.264	4.272	4.281	4.290	4.298	930
940	4.298	4.307	4.316	4.325	4.333	4.342	4.351	4.359	4.368	4.377	4.386	940
950	4.386	4.394	4.403	4.412	4.421	4.430	4.438	4.447	4.456	4.465	4.474	950
960	4.474	4.483	4.491	4.500	4.509	4.518	4.527	4.536	4.545	4.553	4.562	960
970	4.562	4.571	4.580	4.589	4.598	4.607	4.616	4.625	4.634	4.643	4.652	970
980	4.652	4.661	4.670	4.679	4.688	4.697	4.706	4.715	4.724	4.733	4.742	980
990	4.742	4.751	4.760	4.769	4.778	4.787	4.796	4.805	4.814	4.824	4.833	990
1,000	4.833	4.842	4.851	4.860	4.869	4.878	4.887	4.897	4.906	4.915	4.924	1,000
1,010	4.924	4.933	4.942	4.952	4.961	4.970	4.979	4.989	4.998	5.007	5.016	1,010
1,020	5.016	5.025	5.035	5.044	5.053	5.063	5.072	5.081	5.090	5.100	5.109	1,020
1,030	5.109	5.118	5.128	5.137	5.146	5.156	5.165	5.174	5.184	5.193	5.202	1,030
1,040	5.202	5.212	5.221	5.231	5.240	5.249	5.259	5.268	5.278	5.287	5.297	1,040
1,050	5.297	5.306	5.316	5.325	5.334	5.344	5.353	5.363	5.372	5.382	5.391	1,050
1,060	5.391	5.401	5.410	5.420	5.429	5.439	5.449	5.458	5.468	5.477	5.487	1,060
1,070	5.487	5.496	5.506	5.516	5.525	5.535	5.544	5.554	5.564	5.573	5.583	1,070
1,080	5.583	5.593	5.602	5.612	5.621	5.631	5.641	5.651	5.660	5.670	5.680	1,080
1,090	5.680	5.689	5.699	5.709	5.718	5.728	5.738	5.748	5.757	5.767	5.777	1,090
1,100	5.777	5.787	5.796	5.806	5.816	5.826	5.836	5.845	5.855	5.865	5.875	1,100
1,110	5.875	5.885	5.895	5.904	5.914	5.924	5.934	5.944	5.954	5.964	5.973	1,110
1,120	5.973	5.983	5.993	6.003	6.013	6.023	6.033	6.043	6.053	6.063	6.073	1,120
1,130	6.073	6.083	6.093	6.102	6.112	6.122	6.132	6.142	6.152	6.162	6.172	1,130
1,140	6.172	6.182	6.192	6.202	6.212	6.223	6.233	6.243	6.253	6.263	6.273	1,140
1,150	6.273	6.283	6.293	6.303	6.313	6.323	6.333	6.343	6.353	6.364	6.374	1,150
1,160	6.374	6.384	6.394	6.404	6.414	6.424	6.435	6.445	6.455	6.465	6.475	1,160
1,170	6.475	6.485	6.496	6.506	6.516	6.526	6.536	6.547	6.557	6.567	6.577	1,170
1,180	6.577	6.588	6.598	6.608	6.618	6.629	6.639	6.649	6.659	6.670	6.680	1,180
1,190	6.680	6.690	6.701	6.711	6.721	6.732	6.742	6.752	6.763	6.773	6.783	1,190
1,200	6.783	6.794	6.804	6.814	6.825	6.835	6.846	6.856	6.866	6.877	6.887	1,200
1,210	6.887	6.898	6.908	6.918	6.929	6.939	6.950	6.960	6.971	6.981	6.991	1,210
1,220	6.991	7.002	7.012	7.023	7.033	7.044	7.054	7.065	7.075	7.086	7.096	1,220
1,230	7.096	7.107	7.117	7.128	7.138	7.149	7.159	7.170	7.181	7.191	7.202	1,230
1,240	7.202	7.212	7.223	7.233	7.244	7.255	7.265	7.276	7.286	7.297	7.308	1,240
1,250	7.308	7.318	7.329	7.339	7.350	7.361	7.371	7.382	7.393	7.403	7.414	1,250
1,260	7.414	7.425	7.435	7.446	7.457	7.467	7.478	7.489	7.500	7.510	7.521	1,260
1,270	7.521	7.532	7.542	7.553	7.564	7.575	7.585	7.596	7.607	7.618	7.628	1,270
1,280	7.628	7.639	7.650	7.661	7.671	7.682	7.693	7.704	7.715	7.725	7.736	1,280
1,290	7.736	7.747	7.758	7.769	7.780	7.790	7.801	7.812	7.823	7.834	7.845	1,290
1,300	7.845	7.855	7.866	7.877	7.888	7.899	7.910	7.921	7.932	7.943	7.953	1,300
1,310	7.953	7.964	7.975	7.986	7.997	8.008	8.019	8.030	8.041	8.052	8.063	1,310
1,320	8.063	8.074	8.085	8.096	8.107	8.118	8.128	8.139	8.150	8.161	8.172	1,320
1,330	8.172	8.183	8.194	8.205	8.216	8.227	8.238	8.249	8.261	8.272	8.283	1,330
1,340	8.283	8.294	8.305	8.316	8.327	8.338	8.349	8.360	8.371	8.382	8.393	1,340
1,350	8.393	8.404	8.415	8.426	8.437	8.449	8.460	8.471	8.482	8.493	8.504	1,350
1,360	8.504	8.515	8.526	8.538	8.549	8.560	8.571	8.582	8.593	8.604	8.616	1,360
1,370	8.616	8.627	8.638	8.649	8.660	8.671	8.683	8.694	8.705	8.716	8.727	1,370
1,380	8.727	8.738	8.750	8.761	8.772	8.783	8.795	8.806	8.817	8.828	8.839	1,380
1,390	8.839	8.851	8.862	8.873	8.884	8.896	8.907	8.918	8.929	8.941	8.952	1,390
1,400	8.952	8.963	8.974	8.986	8.997	9.008	9.020	9.031	9.042	9.053	9.065	1,400
1,410	9.065	9.076	9.087	9.099	9.110	9.121	9.133	9.144	9.155	9.167	9.178	1,410
1,420	9.178	9.189	9.201	9.212	9.223	9.235	9.246	9.257	9.269	9.280	9.291	1,420
1,430	9.291	9.303	9.314	9.326	9.337	9.348	9.360	9.371	9.382	9.394	9.405	1,430
1,440	9.405	9.417	9.428	9.439	9.451	9.462	9.474	9.485	9.497	9.508	9.519	1,440
1,450	9.519	9.531	9.542	9.554	9.565	9.577	9.588	9.599	9.611	9.622	9.634	1,450
1,460	9.634	9.645	9.657	9.668	9.680	9.691	9.703	9.714	9.726	9.737	9.748	1,460
1,470	9.748	9.760	9.771	9.783	9.794	9.806	9.817	9.829	9.840	9.852	9.863	1,470
1,480	9.863	9.875	9.886	9.898	9.909	9.921	9.933	9.944	9.956	9.967	9.979	1,480
1,490	9.979	9.990	10.002	10.013	10.025	10.036	10.048	10.059	10.071	10.082	10.094	1,490
1,500	10.094	10.106	10.117	10.129	10.140	10.152	10.163	10.175	10.187	10.198	10.210	1,500
1,510	10.210	10.221	10.233	10.244	10.256	10.268	10.279	10.291	10.302	10.314	10.325	1,510
1,520	10.325	10.337	10.349	10.360	10.372	10.383	10.395	10.407	10.418	10.430	10.441	1,520
1,530	10.441	10.453	10.465	10.476	10.488	10.500	10.511	10.523	10.534	10.546	10.558	1,530
1,540	10.558	10.569	10.581	10.593	10.604	10.616	10.627	10.639	10.651	10.662	10.674	1,540
1,550	10.674	10.686	10.697	10.709	10.721	10.732	10.744	10.756	10.767	10.779	10.790	1,550
1,560	10.790	10.802	10.814	10.825	10.837	10.849	10.860	10.872	10.884	10.895	10.907	1,560
1,570	10.907	10.919	10.930	10.942	10.954	10.965	10.977	10.989	11.000	11.012	11.024	1,570
1,580	11.024	11.035	11.047	11.059	11.070	11.082	11.094	11.105	11.117	11.129	11.141	1,580
1,590	11.141	11.152	11.164	11.176	11.187	11.199	11.211	11.222	11.234	11.246	11.257	1,590
1,600	11.257	11.269	11.281	11.292	11.304	11.316	11.328	11.339	11.351	11.363	11.374	1,600
1,610	11.374	11.386	11.398	11.409	11.421	11.433	11.444	11.456	11.468	11.480	11.491	1,610
1,620	11.491	11.503	11.515	11.526	11.538	11.550	11.561	11.573	11.585	11.597	11.608	1,620
1,630	11.608	11.620	11.632	11.643	11.655	11.667	11.678	11.690	11.702	11.714	11.725	1,630
1,640	11.725	11.737	11.749	11.760	11.772	11.784	11.795	11.807	11.819	11.830	11.842	1,640
1,650	11.842	11.854	11.866	11.877	11.889	11.901	11.912	11.924	11.936	11.947	11.959	1,650
1,660	11.959	11.971	11.983	11.994	12.006	12.018	12.029	12.041	12.053	12.064	12.076	1,660
1,670	12.076	12.088	12.099	12.111	12.123	12.134	12.146	12.158	12.170	12.181	12.193	1,670
1,680	12.193	12.205	12.216	12.228	12.240	12.251	12.263	12.275	12.286	12.298	12.310	1,680
1,690	12.310	12.321	12.333	12.345	12.356	12.368	12.380	12.391	12.403	12.415	12.426	1,690
1,700	12.426	12.438	12.450	12.461	12.473	12.485	12.496	12.508	12.520	12.531	12.543	1,700
1,710	12.543	12.555	12.566	12.578	12.590	12.601	12.613	12.624	12.636	12.648	12.659	1,710
1,720	12.659	12.671	12.683	12.694	12.706	12.718	12.729	12.741	12.752	12.764	12.776	1,720
1,730	12.776	12.787	12.799	12.811	12.822	12.834	12.845	12.857	12.869	12.880	12.892	1,730
1,740	12.892	12.903	12.915	12.927	12.938	12.950	12.961	12.973	12.985	12.996	13.008	1,740
1,750	13.008	13.019	13.031	13.043	13.054	13.066	13.077	13.089	13.100	13.112	13.124	1,750
1,760	13.124	13.135	13.147	13.158	13.170	13.181	13.193	13.204	13.216	13.228	13.239	1,760
1,770	13.239	13.251	13.262	13.274	13.285	13.297	13.308	13.320	13.331	13.343	13.354	1,770
1,780	13.354	13.366	13.378	13.389	13.401	13.412	13.424	13.435	13.447	13.458	13.470	1,780
1,790	13.470	13.481	13.493	13.504	13.516	13.527	13.539	13.550	13.562	13.573	13.585	1,790
1,800	13.585	13.596	13.607	13.619	13.630	13.642	13.653	13.665	13.676	13.688	13.699	1,800
1,810	13.699	13.711	13.722	13.733	13.745	13.756	13.768	13.779	13.791	13.802	13.814	1,810
1,820	13.814											1,820
DEG C	0	1	2	3	4	5	6	7	8	9	10	DEG C

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An OMEGA Group Company
One Omega Drive, Box 4047, Stamford, CT 06907
(203) 359-1660 Telex 996404 Cable OMEGA

TABLE VIII

TYPE J

New Reference Tables
Supersedes N.B.S.
Circular #561

Iron Vs. Copper-Nickel

(Iron-Constantan)

Temperature in Degrees F
Reference Junction at 32°F

THERMOELECTRIC VOLTAGE IN ABSOLUTE MILLIVOLTS

DEG F	0	1	2	3	4	5	6	7	8	9	10	DEG F
-350	-8.137											-350
-340	-8.030	-8.041	-8.052	-8.063	-8.074	-8.085	-8.096	-8.106	-8.117	-8.127	-8.137	-340
-330	-7.915	-7.927	-7.938	-7.950	-7.962	-7.973	-7.985	-7.996	-8.008	-8.019	-8.030	-330
-320	-7.791	-7.803	-7.816	-7.829	-7.841	-7.854	-7.866	-7.878	-7.890	-7.903	-7.915	-320
-310	-7.659	-7.672	-7.686	-7.699	-7.712	-7.726	-7.739	-7.752	-7.765	-7.778	-7.791	-310
-300	-7.519	-7.533	-7.548	-7.562	-7.576	-7.590	-7.604	-7.618	-7.631	-7.645	-7.659	-300
-290	-7.372	-7.387	-7.402	-7.417	-7.432	-7.447	-7.461	-7.476	-7.490	-7.505	-7.519	-290
-280	-7.218	-7.234	-7.250	-7.265	-7.281	-7.296	-7.311	-7.327	-7.342	-7.357	-7.372	-280
-270	-7.057	-7.074	-7.090	-7.106	-7.122	-7.139	-7.155	-7.171	-7.187	-7.202	-7.218	-270
-260	-6.890	-6.907	-6.924	-6.941	-6.958	-6.974	-6.991	-7.008	-7.024	-7.041	-7.057	-260
-250	-6.716	-6.734	-6.751	-6.769	-6.786	-6.804	-6.821	-6.838	-6.856	-6.873	-6.890	-250
-240	-6.536	-6.554	-6.572	-6.591	-6.609	-6.627	-6.645	-6.663	-6.680	-6.698	-6.716	-240
-230	-6.350	-6.369	-6.388	-6.407	-6.425	-6.444	-6.462	-6.481	-6.499	-6.518	-6.536	-230
-220	-6.159	-6.178	-6.198	-6.217	-6.236	-6.255	-6.274	-6.293	-6.312	-6.331	-6.350	-220
-210	-5.962	-5.982	-6.002	-6.022	-6.041	-6.061	-6.081	-6.100	-6.120	-6.139	-6.159	-210
-200	-5.760	-5.780	-5.801	-5.821	-5.841	-5.861	-5.882	-5.902	-5.922	-5.942	-5.962	-200
-190	-5.553	-5.574	-5.594	-5.615	-5.636	-5.657	-5.678	-5.698	-5.719	-5.739	-5.760	-190
-180	-5.341	-5.362	-5.383	-5.405	-5.426	-5.447	-5.468	-5.490	-5.511	-5.532	-5.553	-180
-170	-5.124	-5.146	-5.168	-5.190	-5.211	-5.233	-5.255	-5.276	-5.298	-5.319	-5.341	-170
-160	-4.903	-4.925	-4.948	-4.970	-4.992	-5.014	-5.036	-5.058	-5.080	-5.102	-5.124	-160
-150	-4.678	-4.700	-4.723	-4.746	-4.768	-4.791	-4.813	-4.836	-4.858	-4.881	-4.903	-150
-140	-4.448	-4.471	-4.494	-4.517	-4.540	-4.563	-4.586	-4.609	-4.632	-4.655	-4.678	-140
-130	-4.215	-4.238	-4.262	-4.285	-4.309	-4.332	-4.355	-4.379	-4.402	-4.425	-4.448	-130
-120	-3.978	-4.001	-4.025	-4.049	-4.073	-4.097	-4.120	-4.144	-4.168	-4.191	-4.215	-120
-110	-3.737	-3.761	-3.785	-3.809	-3.833	-3.858	-3.882	-3.906	-3.930	-3.954	-3.978	-110
-100	-3.492	-3.517	-3.541	-3.566	-3.590	-3.615	-3.639	-3.664	-3.688	-3.712	-3.737	-100
-90	-3.245	-3.270	-3.294	-3.319	-3.344	-3.369	-3.394	-3.418	-3.443	-3.468	-3.492	-90
-80	-2.994	-3.019	-3.044	-3.069	-3.094	-3.120	-3.145	-3.170	-3.195	-3.220	-3.245	-80
-70	-2.740	-2.765	-2.791	-2.816	-2.842	-2.867	-2.892	-2.918	-2.943	-2.968	-2.994	-70
-60	-2.483	-2.509	-2.534	-2.560	-2.586	-2.612	-2.637	-2.663	-2.689	-2.714	-2.740	-60
-50	-2.223	-2.249	-2.275	-2.301	-2.327	-2.353	-2.379	-2.405	-2.431	-2.457	-2.483	-50
-40	-1.960	-1.987	-2.013	-2.039	-2.066	-2.092	-2.118	-2.144	-2.171	-2.197	-2.223	-40
-30	-1.695	-1.722	-1.748	-1.775	-1.802	-1.828	-1.855	-1.881	-1.908	-1.934	-1.960	-30
-20	-1.428	-1.455	-1.481	-1.508	-1.535	-1.562	-1.589	-1.615	-1.642	-1.669	-1.695	-20
-10	-1.158	-1.185	-1.212	-1.239	-1.266	-1.293	-1.320	-1.347	-1.374	-1.401	-1.428	-10
0	-0.885	-0.913	-0.940	-0.967	-0.995	-1.022	-1.049	-1.076	-1.103	-1.131	-1.158	0

DEG F	0	1	2	3	4	5	6	7	8	9	10	DEG F
0	-0.885	-0.858	-0.831	-0.803	-0.776	-0.748	-0.721	-0.694	-0.666	-0.639	-0.611	0
10	-0.611	-0.583	-0.556	-0.528	-0.501	-0.473	-0.445	-0.418	-0.390	-0.362	-0.334	10
20	-0.334	-0.307	-0.279	-0.251	-0.223	-0.195	-0.168	-0.140	-0.112	-0.084	-0.056	20
30	-0.056	-0.028	0.000	0.028	0.056	0.084	0.112	0.140	0.168	0.196	0.224	30
40	0.224	0.253	0.281	0.309	0.337	0.365	0.394	0.422	0.450	0.478	0.507	40
50	0.507	0.535	0.563	0.592	0.620	0.648	0.677	0.705	0.734	0.762	0.791	50
60	0.791	0.819	0.848	0.876	0.905	0.933	0.962	0.990	1.019	1.048	1.076	60
70	1.076	1.105	1.134	1.162	1.191	1.220	1.248	1.277	1.306	1.335	1.363	70
80	1.363	1.392	1.421	1.450	1.479	1.507	1.536	1.565	1.594	1.623	1.652	80
90	1.652	1.681	1.710	1.739	1.768	1.797	1.826	1.855	1.884	1.913	1.942	90
100	1.942	1.971	2.000	2.029	2.058	2.088	2.117	2.146	2.175	2.204	2.233	100
110	2.233	2.263	2.292	2.321	2.350	2.380	2.409	2.438	2.467	2.497	2.526	110
120	2.526	2.555	2.585	2.614	2.644	2.673	2.702	2.732	2.761	2.791	2.820	120
130	2.820	2.849	2.879	2.908	2.938	2.967	2.997	3.026	3.056	3.085	3.115	130
140	3.115	3.145	3.174	3.204	3.233	3.263	3.293	3.322	3.352	3.381	3.411	140
150	3.411	3.441	3.470	3.500	3.530	3.560	3.589	3.619	3.649	3.678	3.708	150
160	3.708	3.738	3.768	3.798	3.827	3.857	3.887	3.917	3.947	3.976	4.006	160
170	4.006	4.036	4.066	4.096	4.126	4.156	4.186	4.216	4.245	4.275	4.305	170
180	4.305	4.335	4.365	4.395	4.425	4.455	4.485	4.515	4.545	4.575	4.605	180
190	4.605	4.635	4.665	4.695	4.725	4.755	4.786	4.816	4.846	4.876	4.906	190
200	4.906	4.936	4.966	4.996	5.026	5.057	5.087	5.117	5.147	5.177	5.207	200
210	5.207	5.238	5.268	5.298	5.328	5.358	5.389	5.419	5.449	5.479	5.509	210
220	5.509	5.540	5.570	5.600	5.630	5.661	5.691	5.721	5.752	5.782	5.812	220
230	5.812	5.843	5.873	5.903	5.934	5.964	5.994	6.025	6.055	6.085	6.116	230
240	6.116	6.146	6.176	6.207	6.237	6.268	6.298	6.328	6.359	6.389	6.420	240
250	6.420	6.450	6.481	6.511	6.541	6.572	6.602	6.633	6.663	6.694	6.724	250
260	6.724	6.755	6.785	6.816	6.846	6.877	6.907	6.938	6.968	6.999	7.029	260
270	7.029	7.060	7.090	7.121	7.151	7.182	7.212	7.243	7.274	7.304	7.335	270
280	7.335	7.365	7.396	7.426	7.457	7.488	7.518	7.549	7.579	7.610	7.641	280
290	7.641	7.671	7.702	7.732	7.763	7.794	7.824	7.855	7.885	7.916	7.947	290
300	7.947	7.977	8.008	8.039	8.069	8.100	8.131	8.161	8.192	8.223	8.253	300
310	8.253	8.284	8.315	8.345	8.376	8.407	8.437	8.468	8.499	8.530	8.560	310
320	8.560	8.591	8.622	8.652	8.683	8.714	8.745	8.775	8.806	8.837	8.867	320
330	8.867	8.898	8.929	8.960	8.990	9.021	9.052	9.083	9.113	9.144	9.175	330
340	9.175	9.206	9.236	9.267	9.298	9.329	9.359	9.390	9.421	9.452	9.483	340
350	9.483	9.513	9.544	9.575	9.606	9.636	9.667	9.698	9.729	9.760	9.790	350
360	9.790	9.821	9.852	9.883	9.914	9.944	9.975	10.006	10.037	10.068	10.098	360
370	10.098	10.129	10.160	10.191	10.222	10.252	10.283	10.314	10.345	10.376	10.407	370
380	10.407	10.437	10.468	10.499	10.530	10.561	10.592	10.622	10.653	10.684	10.715	380
390	10.715	10.746	10.777	10.807	10.838	10.869	10.900	10.931	10.962	10.992	11.023	390
400	11.023	11.054	11.085	11.116	11.147	11.177	11.208	11.239	11.270	11.301	11.332	400
410	11.332	11.363	11.393	11.424	11.455	11.486	11.517	11.548	11.578	11.609	11.640	410
420	11.640	11.671	11.702	11.733	11.764	11.794	11.825	11.856	11.887	11.918	11.949	420
430	11.949	11.980	12.010	12.041	12.072	12.103	12.134	12.165	12.196	12.226	12.257	430
440	12.257	12.288	12.319	12.350	12.381	12.411	12.442	12.473	12.504	12.535	12.566	440
450	12.566	12.597	12.627	12.658	12.689	12.720	12.751	12.782	12.813	12.843	12.874	450
460	12.874	12.905	12.936	12.967	12.998	13.029	13.059	13.090	13.121	13.152	13.183	460
470	13.183	13.214	13.244	13.275	13.306	13.337	13.368	13.399	13.430	13.460	13.491	470
480	13.491	13.522	13.553	13.584	13.615	13.645	13.676	13.707	13.738	13.769	13.800	480
490	13.800	13.830	13.861	13.892	13.923	13.954	13.985	14.015	14.046	14.077	14.108	490
500	14.108	14.139	14.170	14.200	14.231	14.262	14.293	14.324	14.355	14.385	14.416	500
510	14.416	14.447	14.478	14.509	14.539	14.570	14.601	14.632	14.663	14.694	14.724	510
520	14.724	14.755	14.786	14.817	14.848	14.878	14.909	14.940	14.971	15.002	15.032	520
530	15.032	15.063	15.094	15.125	15.156	15.186	15.217	15.248	15.279	15.310	15.340	530
540	15.340	15.371	15.402	15.433	15.464	15.494	15.525	15.556	15.587	15.617	15.648	540
550	15.648	15.679	15.710	15.741	15.771	15.802	15.833	15.864	15.894	15.925	15.956	550
560	15.956	15.987	16.018	16.048	16.079	16.110	16.141	16.171	16.202	16.233	16.264	560
570	16.264	16.294	16.325	16.356	16.387	16.417	16.448	16.479	16.510	16.540	16.571	570
580	16.571	16.602	16.633	16.663	16.694	16.725	16.756	16.786	16.817	16.848	16.879	580
590	16.879	16.909	16.940	16.971	17.001	17.032	17.063	17.094	17.124	17.155	17.186	590
600	17.186	17.217	17.247	17.278	17.309	17.339	17.370	17.401	17.432	17.462	17.493	600
DEG F	0	1	2	3	4	5	6	7	8	9	10	DEG F

* CONVERTED FROM DEGREES C(IPTS 1968).

OMEGA ENGINEERING, INC.
An OMEGA Group Company
One Omega Drive, Box 4047, Stamford, CT 06907
(203) 359-1660 Telex 996404 Cable OMEGA

TABLE VIII — Continued

TYPE J

New Reference Tables
Supersedes N.B.S.
Circular #561

Iron Vs. Copper-Nickel
(Iron-Constantan)

Temperature in Degrees F
Reference Junction at 32°F

THERMOELECTRIC VOLTAGE IN ABSOLUTE MILLIVOLTS

DEG F	0	1	2	3	4	5	6	7	8	9	10	DEG F
600	17.186	17.217	17.247	17.278	17.309	17.339	17.370	17.401	17.432	17.462	17.493	600
610	17.493	17.524	17.554	17.585	17.616	17.646	17.677	17.708	17.739	17.769	17.800	610
620	17.800	17.831	17.861	17.892	17.923	17.953	17.984	18.015	18.046	18.076	18.107	620
630	18.107	18.138	18.168	18.199	18.230	18.260	18.291	18.322	18.352	18.383	18.414	630
640	18.414	18.444	18.475	18.506	18.537	18.567	18.598	18.629	18.659	18.690	18.721	640
650	18.721	18.751	18.782	18.813	18.843	18.874	18.905	18.935	18.966	18.997	19.027	650
660	19.027	19.058	19.089	19.119	19.150	19.180	19.211	19.242	19.272	19.303	19.334	660
670	19.334	19.364	19.395	19.426	19.456	19.487	19.518	19.548	19.579	19.610	19.640	670
680	19.640	19.671	19.702	19.732	19.763	19.793	19.824	19.855	19.885	19.916	19.947	680
690	19.947	19.977	20.008	20.039	20.069	20.100	20.131	20.161	20.192	20.222	20.253	690
700	20.253	20.284	20.314	20.345	20.376	20.406	20.437	20.467	20.498	20.529	20.559	700
710	20.559	20.590	20.621	20.651	20.682	20.713	20.743	20.774	20.804	20.835	20.866	710
720	20.866	20.896	20.927	20.958	20.988	21.019	21.049	21.080	21.111	21.141	21.172	720
730	21.172	21.203	21.233	21.264	21.295	21.325	21.356	21.386	21.417	21.448	21.478	730
740	21.478	21.509	21.540	21.570	21.601	21.631	21.662	21.693	21.723	21.754	21.785	740
750	21.785	21.815	21.846	21.877	21.907	21.938	21.968	21.999	22.030	22.060	22.091	750
760	22.091	22.122	22.152	22.183	22.214	22.244	22.275	22.305	22.336	22.367	22.397	760
770	22.397	22.428	22.459	22.489	22.520	22.551	22.581	22.612	22.643	22.673	22.704	770
780	22.704	22.735	22.765	22.796	22.826	22.857	22.888	22.918	22.949	22.980	23.010	780
790	23.010	23.041	23.072	23.102	23.133	23.164	23.194	23.225	23.256	23.286	23.317	790
800	23.317	23.348	23.378	23.409	23.440	23.471	23.501	23.532	23.563	23.593	23.624	800
810	23.624	23.655	23.685	23.716	23.747	23.777	23.808	23.839	23.870	23.900	23.931	810
820	23.931	23.962	23.992	24.023	24.054	24.085	24.115	24.146	24.177	24.207	24.238	820
830	24.238	24.269	24.300	24.330	24.361	24.392	24.423	24.453	24.484	24.515	24.546	830
840	24.546	24.576	24.607	24.638	24.669	24.699	24.730	24.761	24.792	24.822	24.853	840
850	24.853	24.884	24.915	24.946	24.976	25.007	25.038	25.069	25.099	25.130	25.161	850
860	25.161	25.192	25.223	25.254	25.284	25.315	25.346	25.377	25.408	25.438	25.469	860
870	25.469	25.500	25.531	25.562	25.593	25.623	25.654	25.685	25.716	25.747	25.778	870
880	25.778	25.809	25.840	25.870	25.901	25.932	25.963	25.994	26.025	26.056	26.087	880
890	26.087	26.118	26.148	26.179	26.210	26.241	26.272	26.303	26.334	26.365	26.396	890
900	26.396	26.427	26.458	26.489	26.520	26.551	26.582	26.613	26.644	26.675	26.705	900
910	26.705	26.736	26.767	26.798	26.829	26.860	26.891	26.922	26.954	26.985	27.016	910
920	27.016	27.047	27.078	27.109	27.140	27.171	27.202	27.233	27.264	27.295	27.326	920
930	27.326	27.357	27.388	27.419	27.450	27.482	27.513	27.544	27.575	27.606	27.637	930
940	27.637	27.668	27.699	27.731	27.762	27.793	27.824	27.855	27.886	27.917	27.949	940
950	27.949	27.980	28.011	28.042	28.073	28.105	28.136	28.167	28.198	28.230	28.261	950
960	28.261	28.292	28.323	28.355	28.386	28.417	28.448	28.480	28.511	28.542	28.573	960
970	28.573	28.605	28.636	28.667	28.699	28.730	28.761	28.793	28.824	28.855	28.887	970
980	28.887	28.918	28.950	28.981	29.012	29.044	29.075	29.107	29.138	29.169	29.201	980
990	29.201	29.232	29.264	29.295	29.327	29.358	29.390	29.421	29.452	29.484	29.515	990
1,000	29.515	29.547	29.578	29.610	29.642	29.673	29.705	29.736	29.768	29.799	29.831	1,000
1,010	29.831	29.862	29.894	29.926	29.957	29.989	30.020	30.052	30.084	30.115	30.147	1,010
1,020	30.147	30.179	30.210	30.242	30.274	30.305	30.337	30.369	30.400	30.432	30.464	1,020
1,030	30.464	30.496	30.527	30.559	30.591	30.623	30.654	30.686	30.718	30.750	30.782	1,030
1,040	30.782	30.813	30.845	30.877	30.909	30.941	30.973	31.005	31.036	31.068	31.100	1,040
1,050	31.100	31.132	31.164	31.196	31.228	31.260	31.292	31.324	31.356	31.388	31.420	1,050
1,060	31.420	31.452	31.484	31.516	31.548	31.580	31.612	31.644	31.676	31.708	31.740	1,060
1,070	31.740	31.772	31.804	31.836	31.868	31.901	31.933	31.965	31.997	32.029	32.061	1,070
1,080	32.061	32.094	32.126	32.158	32.190	32.222	32.255	32.287	32.319	32.351	32.384	1,080
1,090	32.384	32.416	32.448	32.480	32.513	32.545	32.577	32.610	32.642	32.674	32.707	1,090
1,100	32.707	32.739	32.772	32.804	32.836	32.869	32.901	32.934	32.966	32.999	33.031	1,100
1,110	33.031	33.064	33.096	33.129	33.161	33.194	33.226	33.259	33.291	33.324	33.356	1,110
1,120	33.356	33.389	33.422	33.454	33.487	33.519	33.552	33.585	33.617	33.650	33.683	1,120
1,130	33.683	33.715	33.748	33.781	33.814	33.846	33.879	33.912	33.945	33.977	34.010	1,130
1,140	34.010	34.043	34.076	34.109	34.141	34.174	34.207	34.240	34.273	34.306	34.339	1,140
1,150	34.339	34.372	34.405	34.437	34.470	34.503	34.536	34.569	34.602	34.635	34.668	1,150
1,160	34.668	34.701	34.734	34.767	34.801	34.834	34.867	34.900	34.933	34.966	34.999	1,160
1,170	34.999	35.032	35.065	35.099	35.132	35.165	35.198	35.231	35.265	35.298	35.331	1,170
1,180	35.331	35.364	35.398	35.431	35.464	35.498	35.531	35.564	35.598	35.631	35.664	1,180
1,190	35.664	35.698	35.731	35.764	35.798	35.831	35.865	35.898	35.932	35.965	35.999	1,190
1,200	35.999	36.032	36.066	36.099	36.133	36.166	36.200	36.233	36.267	36.301	36.334	1,200
1,210	36.334	36.368	36.401	36.435	36.469	36.502	36.536	36.570	36.603	36.637	36.671	1,210
1,220	36.671	36.705	36.738	36.772	36.806	36.840	36.873	36.907	36.941	36.975	37.009	1,220
1,230	37.009	37.043	37.076	37.110	37.144	37.178	37.212	37.246	37.280	37.314	37.348	1,230
1,240	37.348	37.382	37.416	37.450	37.484	37.518	37.552	37.586	37.620	37.654	37.688	1,240
1,250	37.688	37.722	37.756	37.790	37.825	37.859	37.893	37.927	37.961	37.995	38.030	1,250
1,260	38.030	38.064	38.098	38.132	38.167	38.201	38.235	38.269	38.304	38.338	38.372	1,260
1,270	38.372	38.407	38.441	38.475	38.510	38.544	38.578	38.613	38.647	38.682	38.716	1,270
1,280	38.716	38.751	38.785	38.819	38.854	38.888	38.923	38.957	38.992	39.027	39.061	1,280
1,290	39.061	39.096	39.130	39.165	39.199	39.234	39.269	39.303	39.338	39.373	39.407	1,290
1,300	39.407	39.442	39.477	39.511	39.546	39.581	39.615	39.650	39.685	39.720	39.754	1,300
1,310	39.754	39.789	39.824	39.859	39.894	39.928	39.963	39.998	40.033	40.068	40.103	1,310
1,320	40.103	40.138	40.172	40.207	40.242	40.277	40.312	40.347	40.382	40.417	40.452	1,320
1,330	40.452	40.487	40.522	40.557	40.592	40.627	40.662	40.697	40.732	40.767	40.802	1,330
1,340	40.802	40.837	40.872	40.908	40.943	40.978	41.013	41.048	41.083	41.118	41.154	1,340
1,350	41.154	41.189	41.224	41.259	41.294	41.329	41.365	41.400	41.435	41.470	41.506	1,350
1,360	41.506	41.541	41.576	41.611	41.647	41.682	41.717	41.753	41.788	41.823	41.859	1,360
1,370	41.859	41.894	41.929	41.965	42.000	42.035	42.071	42.106	42.142	42.177	42.212	1,370
1,380	42.212	42.248	42.283	42.319	42.354	42.390	42.425	42.460	42.496	42.531	42.567	1,380
1,390	42.567	42.602	42.638	42.673	42.709	42.744	42.780	42.815	42.851	42.886	42.922	1,390
DEG F	0	1	2	3	4	5	6	7	8	9	10	DEG F

* CONVERTED FROM DEGREES C(IPTS 1968).

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TABLE IX

TYPE K

New Reference Tables
Supersedes N.B.S.
Circular #561

Nickel-Chromium Vs. Nickel-Aluminum

(Chromel-Alumel)*

Temperature in Degrees F
Reference Junction at 32°F

THERMOELECTRIC VOLTAGE IN ABSOLUTE MILLIVOLTS

DEG F	0	1	2	3	4	5	6	7	8	9	10	DEG F
-450	-6.456	-6.456	-6.457	-6.457	-6.458							-450
-440	-6.447	-6.448	-6.449	-6.450	-6.451	-6.452	-6.453	-6.454	-6.454	-6.455	-6.456	-440
-430	-6.431	-6.433	-6.435	-6.436	-6.438	-6.440	-6.441	-6.443	-6.444	-6.445	-6.447	-430
-420	-6.409	-6.411	-6.414	-6.416	-6.419	-6.421	-6.423	-6.425	-6.427	-6.429	-6.431	-420
-410	-6.380	-6.383	-6.386	-6.389	-6.392	-6.395	-6.398	-6.401	-6.404	-6.406	-6.409	-410
-400	-6.344	-6.348	-6.352	-6.355	-6.359	-6.363	-6.366	-6.370	-6.373	-6.377	-6.380	-400
-390	-6.301	-6.306	-6.310	-6.315	-6.319	-6.323	-6.328	-6.332	-6.336	-6.340	-6.344	-390
-380	-6.251	-6.257	-6.262	-6.267	-6.272	-6.277	-6.282	-6.287	-6.292	-6.296	-6.301	-380
-370	-6.195	-6.201	-6.207	-6.213	-6.219	-6.224	-6.230	-6.235	-6.241	-6.246	-6.251	-370
-360	-6.133	-6.139	-6.146	-6.152	-6.158	-6.165	-6.171	-6.177	-6.183	-6.189	-6.195	-360
-350	-6.064	-6.071	-6.078	-6.085	-6.092	-6.099	-6.106	-6.113	-6.119	-6.126	-6.133	-350
-340	-5.989	-5.997	-6.004	-6.012	-6.020	-6.027	-6.035	-6.042	-6.049	-6.057	-6.064	-340
-330	-5.908	-5.917	-5.925	-5.933	-5.941	-5.949	-5.957	-5.965	-5.973	-5.981	-5.989	-330
-320	-5.822	-5.831	-5.839	-5.848	-5.857	-5.866	-5.874	-5.883	-5.891	-5.900	-5.908	-320
-310	-5.730	-5.739	-5.748	-5.758	-5.767	-5.776	-5.786	-5.795	-5.804	-5.813	-5.822	-310
-300	-5.632	-5.642	-5.652	-5.662	-5.672	-5.682	-5.691	-5.701	-5.711	-5.720	-5.730	-300
-290	-5.529	-5.540	-5.550	-5.561	-5.571	-5.581	-5.592	-5.602	-5.612	-5.622	-5.632	-290
-280	-5.421	-5.432	-5.443	-5.454	-5.465	-5.476	-5.487	-5.497	-5.508	-5.519	-5.529	-280
-270	-5.308	-5.319	-5.331	-5.342	-5.354	-5.365	-5.376	-5.388	-5.399	-5.410	-5.421	-270
-260	-5.190	-5.202	-5.214	-5.226	-5.238	-5.249	-5.261	-5.273	-5.285	-5.296	-5.308	-260
-250	-5.067	-5.079	-5.092	-5.104	-5.116	-5.129	-5.141	-5.153	-5.165	-5.178	-5.190	-250
-240	-4.939	-4.952	-4.965	-4.978	-4.990	-5.003	-5.016	-5.029	-5.041	-5.054	-5.067	-240
-230	-4.806	-4.819	-4.833	-4.846	-4.860	-4.873	-4.886	-4.899	-4.912	-4.926	-4.939	-230
-220	-4.669	-4.683	-4.697	-4.710	-4.724	-4.738	-4.752	-4.765	-4.779	-4.792	-4.806	-220
-210	-4.527	-4.541	-4.556	-4.570	-4.584	-4.598	-4.613	-4.627	-4.641	-4.655	-4.669	-210
-200	-4.381	-4.396	-4.410	-4.425	-4.440	-4.454	-4.469	-4.484	-4.498	-4.512	-4.527	-200
-190	-4.230	-4.245	-4.261	-4.276	-4.291	-4.306	-4.321	-4.336	-4.351	-4.366	-4.381	-190
-180	-4.075	-4.091	-4.107	-4.122	-4.138	-4.153	-4.169	-4.184	-4.200	-4.215	-4.230	-180
-170	-3.917	-3.933	-3.949	-3.965	-3.981	-3.997	-4.012	-4.028	-4.044	-4.060	-4.075	-170
-160	-3.754	-3.770	-3.787	-3.803	-3.819	-3.836	-3.852	-3.868	-3.884	-3.901	-3.917	-160
-150	-3.587	-3.604	-3.621	-3.637	-3.654	-3.671	-3.688	-3.704	-3.721	-3.737	-3.754	-150
-140	-3.417	-3.434	-3.451	-3.468	-3.485	-3.502	-3.519	-3.536	-3.553	-3.570	-3.587	-140
-130	-3.242	-3.260	-3.277	-3.295	-3.312	-3.330	-3.347	-3.365	-3.382	-3.399	-3.417	-130
-120	-3.065	-3.082	-3.100	-3.118	-3.136	-3.154	-3.172	-3.189	-3.207	-3.225	-3.242	-120
-110	-2.883	-2.902	-2.920	-2.938	-2.956	-2.974	-2.992	-3.010	-3.029	-3.047	-3.065	-110
-100	-2.699	-2.717	-2.736	-2.754	-2.773	-2.791	-2.810	-2.828	-2.847	-2.865	-2.883	-100
-90	-2.511	-2.530	-2.549	-2.567	-2.586	-2.605	-2.624	-2.643	-2.661	-2.680	-2.699	-90
-80	-2.320	-2.339	-2.358	-2.377	-2.397	-2.416	-2.435	-2.454	-2.473	-2.492	-2.511	-80
-70	-2.126	-2.145	-2.165	-2.184	-2.204	-2.223	-2.243	-2.262	-2.281	-2.300	-2.320	-70
-60	-1.929	-1.949	-1.968	-1.988	-2.008	-2.028	-2.047	-2.067	-2.087	-2.106	-2.126	-60
-50	-1.729	-1.749	-1.769	-1.789	-1.809	-1.829	-1.849	-1.869	-1.889	-1.909	-1.929	-50
-40	-1.527	-1.547	-1.567	-1.588	-1.608	-1.628	-1.648	-1.669	-1.689	-1.709	-1.729	-40
-30	-1.322	-1.342	-1.363	-1.383	-1.404	-1.424	-1.445	-1.465	-1.486	-1.506	-1.527	-30
-20	-1.114	-1.135	-1.156	-1.177	-1.197	-1.218	-1.239	-1.260	-1.280	-1.301	-1.322	-20
-10	-0.904	-0.925	-0.946	-0.968	-0.989	-1.010	-1.031	-1.051	-1.072	-1.093	-1.114	-10
0	-0.692	-0.714	-0.735	-0.756	-0.777	-0.799	-0.820	-0.841	-0.862	-0.883	-0.904	0

DEG F	0	1	2	3	4	5	6	7	8	9	10	DEG F
0	-0.692	-0.671	-0.650	-0.628	-0.607	-0.585	-0.564	-0.543	-0.521	-0.500	-0.478	0
10	-0.478	-0.457	-0.435	-0.413	-0.392	-0.370	-0.349	-0.327	-0.305	-0.284	-0.262	10
20	-0.262	-0.240	-0.218	-0.197	-0.175	-0.153	-0.131	-0.109	-0.088	-0.066	-0.044	20
30	-0.044	-0.022	0.000	0.022	0.044	0.066	0.088	0.110	0.132	0.154	0.176	30
40	0.176	0.198	0.220	0.242	0.264	0.286	0.308	0.331	0.353	0.375	0.397	40
50	0.397	0.419	0.441	0.464	0.486	0.508	0.530	0.553	0.575	0.597	0.619	50
60	0.619	0.642	0.664	0.686	0.709	0.731	0.753	0.776	0.798	0.821	0.843	60
70	0.843	0.865	0.888	0.910	0.933	0.955	0.978	1.000	1.023	1.045	1.068	70
80	1.068	1.090	1.113	1.135	1.158	1.181	1.203	1.226	1.248	1.271	1.294	80
90	1.294	1.316	1.339	1.362	1.384	1.407	1.430	1.452	1.475	1.498	1.520	90
100	1.520	1.543	1.566	1.589	1.611	1.634	1.657	1.680	1.703	1.725	1.748	100
110	1.748	1.771	1.794	1.817	1.839	1.862	1.885	1.908	1.931	1.954	1.977	110
120	1.977	2.000	2.022	2.045	2.068	2.091	2.114	2.137	2.160	2.183	2.206	120
130	2.206	2.229	2.252	2.275	2.298	2.321	2.344	2.367	2.390	2.413	2.436	130
140	2.436	2.459	2.482	2.505	2.528	2.551	2.574	2.597	2.620	2.643	2.666	140
150	2.666	2.689	2.712	2.735	2.758	2.781	2.804	2.827	2.850	2.873	2.896	150
160	2.896	2.920	2.943	2.966	2.989	3.012	3.035	3.058	3.081	3.104	3.127	160
170	3.127	3.150	3.173	3.196	3.220	3.243	3.266	3.289	3.312	3.335	3.358	170
180	3.358	3.381	3.404	3.427	3.450	3.473	3.496	3.519	3.543	3.566	3.589	180
190	3.589	3.612	3.635	3.658	3.681	3.704	3.727	3.750	3.773	3.796	3.819	190
200	3.819	3.842	3.865	3.888	3.911	3.934	3.957	3.980	4.003	4.026	4.049	200
210	4.049	4.072	4.095	4.118	4.141	4.164	4.187	4.210	4.233	4.256	4.279	210
220	4.279	4.302	4.325	4.348	4.371	4.394	4.417	4.439	4.462	4.485	4.508	220
230	4.508	4.531	4.554	4.577	4.600	4.622	4.645	4.668	4.691	4.714	4.737	230
240	4.737	4.759	4.782	4.805	4.828	4.851	4.873	4.896	4.919	4.942	4.964	240
250	4.964	4.987	5.010	5.033	5.055	5.078	5.101	5.124	5.146	5.169	5.192	250
260	5.192	5.214	5.237	5.260	5.282	5.305	5.327	5.350	5.373	5.395	5.418	260
270	5.418	5.440	5.463	5.486	5.508	5.531	5.553	5.576	5.598	5.621	5.643	270
280	5.643	5.666	5.688	5.711	5.733	5.756	5.778	5.801	5.823	5.846	5.868	280
290	5.868	5.891	5.913	5.936	5.958	5.980	6.003	6.025	6.048	6.070	6.092	290
300	6.092	6.115	6.137	6.160	6.182	6.204	6.227	6.249	6.271	6.294	6.316	300
310	6.316	6.338	6.361	6.383	6.405	6.428	6.450	6.472	6.494	6.517	6.539	310
320	6.539	6.561	6.583	6.606	6.628	6.650	6.672	6.695	6.717	6.739	6.761	320
330	6.761	6.784	6.806	6.828	6.850	6.873	6.895	6.917	6.939	6.961	6.984	330
340	6.984	7.006	7.028	7.050	7.072	7.094	7.117	7.139	7.161	7.183	7.205	340
350	7.205	7.228	7.250	7.272	7.294	7.316	7.338	7.361	7.383	7.405	7.427	350
360	7.427	7.449	7.471	7.494	7.516	7.538	7.560	7.582	7.604	7.627	7.649	360
370	7.649	7.671	7.693	7.715	7.737	7.760	7.782	7.804	7.826	7.848	7.870	370
380	7.870	7.893	7.915	7.937	7.959	7.981	8.003	8.026	8.048	8.070	8.092	380
390	8.092	8.114	8.137	8.159	8.181	8.203	8.225	8.248	8.270	8.292	8.314	390
400	8.314	8.336	8.359	8.381	8.403	8.425	8.448	8.470	8.492	8.514	8.537	400
410	8.537	8.559	8.581	8.603	8.626	8.648	8.670	8.692	8.715	8.737	8.759	410
420	8.759	8.782	8.804	8.826	8.849	8.871	8.893	8.916	8.938	8.960	8.983	420
430	8.983	9.005	9.027	9.050	9.072	9.094	9.117	9.139	9.161	9.184	9.206	430
440	9.206	9.229	9.251	9.273	9.296	9.318	9.341	9.363	9.385	9.408	9.430	440
450	9.430	9.453	9.475	9.498	9.520	9.543	9.565	9.588	9.610	9.633	9.655	450
460	9.655	9.678	9.700	9.723	9.745	9.768	9.790	9.813	9.835	9.858	9.880	460
470	9.880	9.903	9.926	9.948	9.971	9.993	10.016	10.038	10.061	10.084	10.106	470
480	10.106	10.129	10.151	10.174	10.197	10.219	10.242	10.265	10.287	10.310	10.333	480
490	10.333	10.355	10.378	10.401	10.423	10.446	10.469	10.491	10.514	10.537	10.560	490
500	10.560	10.582	10.605	10.628	10.650	10.673	10.696	10.719	10.741	10.764	10.787	500
510	10.787	10.810	10.833	10.855	10.878	10.901	10.924	10.947	10.969	10.992	11.015	510
520	11.015	11.038	11.061	11.083	11.106	11.129	11.152	11.175	11.198	11.221	11.243	520
530	11.243	11.266	11.289	11.312	11.335	11.358	11.381	11.404	11.426	11.449	11.472	530
540	11.472	11.495	11.518	11.541	11.564	11.587	11.610	11.633	11.656	11.679	11.702	540
DEG F	0	1	2	3	4	5	6	7	8	9	10	DEG F

CONVERTED FROM DEGREES C(IPTS 1968).

*Equivalent material now available from other manufacturers. See "Trade Names of Alloys" table on page T-38.

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TABLE IX — Continued

TYPE K

New Reference Tables
Supersedes N.B.S.
Circular #561

Nickel-Chromium Vs. Nickel-Aluminum

(Chromel-Alumel)*

Temperature in Degrees F
Reference Junction at 32°F

THERMOELECTRIC VOLTAGE IN ABSOLUTE MILLIVOLTS

DEG F	0	1	2	3	4	5	6	7	8	9	10	DEG F
550	11.702	11.725	11.748	11.770	11.793	11.816	11.839	11.862	11.885	11.908	11.931	550
560	11.931	11.954	11.977	12.000	12.023	12.046	12.069	12.092	12.115	12.138	12.161	560
570	12.161	12.184	12.207	12.230	12.254	12.277	12.300	12.323	12.346	12.369	12.392	570
580	12.392	12.415	12.438	12.461	12.484	12.507	12.530	12.553	12.576	12.599	12.623	580
590	12.623	12.646	12.669	12.692	12.715	12.738	12.761	12.784	12.807	12.831	12.854	590
600	12.854	12.877	12.900	12.923	12.946	12.969	12.992	13.016	13.039	13.062	13.085	600
610	13.085	13.108	13.131	13.154	13.178	13.201	13.224	13.247	13.270	13.293	13.317	610
620	13.317	13.340	13.363	13.386	13.409	13.433	13.456	13.479	13.502	13.525	13.549	620
630	13.549	13.572	13.595	13.618	13.641	13.665	13.688	13.711	13.734	13.757	13.781	630
640	13.781	13.804	13.827	13.850	13.874	13.897	13.920	13.943	13.967	13.990	14.013	640
650	14.013	14.036	14.060	14.083	14.106	14.129	14.153	14.176	14.199	14.222	14.246	650
660	14.246	14.269	14.292	14.316	14.339	14.362	14.385	14.409	14.432	14.455	14.479	660
670	14.479	14.502	14.525	14.548	14.572	14.595	14.618	14.642	14.665	14.688	14.712	670
680	14.712	14.735	14.758	14.782	14.805	14.828	14.852	14.875	14.898	14.922	14.945	680
690	14.945	14.968	14.992	15.015	15.038	15.062	15.085	15.108	15.132	15.155	15.178	690
700	15.178	15.202	15.225	15.248	15.272	15.295	15.318	15.342	15.365	15.389	15.412	700
710	15.412	15.435	15.459	15.482	15.505	15.529	15.552	15.576	15.599	15.622	15.646	710
720	15.646	15.669	15.693	15.716	15.739	15.763	15.786	15.810	15.833	15.856	15.880	720
730	15.880	15.903	15.927	15.950	15.974	15.997	16.020	16.044	16.067	16.091	16.114	730
740	16.114	16.138	16.161	16.184	16.208	16.231	16.255	16.278	16.302	16.325	16.349	740
750	16.349	16.372	16.395	16.419	16.442	16.466	16.489	16.513	16.536	16.560	16.583	750
760	16.583	16.607	16.630	16.654	16.677	16.700	16.724	16.747	16.771	16.794	16.818	760
770	16.818	16.841	16.865	16.888	16.912	16.935	16.959	16.982	17.006	17.029	17.053	770
780	17.053	17.076	17.100	17.123	17.147	17.170	17.194	17.217	17.241	17.264	17.288	780
790	17.288	17.311	17.335	17.358	17.382	17.406	17.429	17.453	17.476	17.500	17.523	790
800	17.523	17.547	17.570	17.594	17.617	17.641	17.664	17.688	17.711	17.735	17.759	800
810	17.759	17.782	17.806	17.829	17.853	17.876	17.900	17.923	17.947	17.971	17.994	810
820	17.994	18.018	18.041	18.065	18.088	18.112	18.136	18.159	18.183	18.206	18.230	820
830	18.230	18.253	18.277	18.301	18.324	18.348	18.371	18.395	18.418	18.442	18.466	830
840	18.466	18.489	18.513	18.536	18.560	18.584	18.607	18.631	18.654	18.678	18.702	840
850	18.702	18.725	18.749	18.772	18.796	18.820	18.843	18.867	18.890	18.914	18.938	850
860	18.938	18.961	18.985	19.008	19.032	19.056	19.079	19.103	19.127	19.150	19.174	860
870	19.174	19.197	19.221	19.245	19.268	19.292	19.316	19.339	19.363	19.386	19.410	870
880	19.410	19.434	19.457	19.481	19.505	19.528	19.552	19.576	19.599	19.623	19.646	880
890	19.646	19.670	19.694	19.717	19.741	19.765	19.788	19.812	19.836	19.859	19.883	890
900	19.883	19.907	19.930	19.954	19.978	20.001	20.025	20.049	20.072	20.096	20.120	900
910	20.120	20.143	20.167	20.190	20.214	20.238	20.261	20.285	20.309	20.332	20.356	910
920	20.356	20.380	20.403	20.427	20.451	20.474	20.498	20.522	20.545	20.569	20.593	920
930	20.593	20.616	20.640	20.664	20.688	20.711	20.735	20.759	20.782	20.806	20.830	930
940	20.830	20.853	20.877	20.901	20.924	20.948	20.972	20.995	21.019	21.043	21.066	940
950	21.066	21.090	21.114	21.137	21.161	21.185	21.208	21.232	21.256	21.280	21.303	950
960	21.303	21.327	21.351	21.374	21.398	21.422	21.445	21.469	21.493	21.516	21.540	960
970	21.540	21.564	21.587	21.611	21.635	21.659	21.682	21.706	21.730	21.753	21.777	970
980	21.777	21.801	21.824	21.848	21.872	21.895	21.919	21.943	21.966	21.990	22.014	980
990	22.014	22.038	22.061	22.085	22.109	22.132	22.156	22.180	22.203	22.227	22.251	990
1,000	22.251	22.274	22.298	22.322	22.346	22.369	22.393	22.417	22.440	22.464	22.488	1,000
1,010	22.488	22.511	22.535	22.559	22.582	22.606	22.630	22.654	22.677	22.701	22.725	1,010
1,020	22.725	22.748	22.772	22.796	22.819	22.843	22.867	22.890	22.914	22.938	22.961	1,020
1,030	22.961	22.985	23.009	23.032	23.056	23.080	23.104	23.127	23.151	23.175	23.198	1,030
1,040	23.198	23.222	23.246	23.269	23.293	23.317	23.340	23.364	23.388	23.411	23.435	1,040
1,050	23.435	23.459	23.482	23.506	23.530	23.553	23.577	23.601	23.624	23.648	23.672	1,050
1,060	23.672	23.695	23.719	23.743	23.766	23.790	23.814	23.837	23.861	23.885	23.908	1,060
1,070	23.908	23.932	23.956	23.979	24.003	24.027	24.050	24.074	24.098	24.121	24.145	1,070
1,080	24.145	24.169	24.192	24.216	24.240	24.263	24.287	24.311	24.334	24.358	24.382	1,080
1,090	24.382	24.405	24.429	24.453	24.476	24.500	24.523	24.547	24.571	24.594	24.618	1,090
1,100	24.618	24.642	24.665	24.689	24.713	24.736	24.760	24.783	24.807	24.831	24.854	1,100
1,110	24.854	24.878	24.902	24.925	24.949	24.972	24.996	25.020	25.043	25.067	25.091	1,110
1,120	25.091	25.114	25.138	25.161	25.185	25.209	25.232	25.256	25.279	25.303	25.327	1,120
1,130	25.327	25.350	25.374	25.397	25.421	25.445	25.468	25.492	25.515	25.539	25.563	1,130
1,140	25.563	25.586	25.610	25.633	25.657	25.681	25.704	25.728	25.751	25.775	25.799	1,140
1,150	25.799	25.822	25.846	25.869	25.893	25.916	25.940	25.964	25.987	26.011	26.034	1,150
1,160	26.034	26.058	26.081	26.105	26.128	26.152	26.176	26.199	26.223	26.246	26.270	1,160
1,170	26.270	26.293	26.317	26.340	26.364	26.387	26.411	26.435	26.458	26.482	26.505	1,170
1,180	26.505	26.529	26.552	26.576	26.599	26.623	26.646	26.670	26.693	26.717	26.740	1,180
1,190	26.740	26.764	26.787	26.811	26.834	26.858	26.881	26.905	26.928	26.952	26.975	1,190
1,200	26.975	26.999	27.022	27.046	27.069	27.093	27.116	27.140	27.163	27.187	27.210	1,200
1,210	27.210	27.234	27.257	27.281	27.304	27.328	27.351	27.375	27.398	27.422	27.445	1,210
1,220	27.445	27.468	27.492	27.515	27.539	27.562	27.586	27.609	27.633	27.656	27.679	1,220
1,230	27.679	27.703	27.726	27.750	27.773	27.797	27.820	27.843	27.867	27.890	27.914	1,230
1,240	27.914	27.937	27.961	27.984	28.007	28.031	28.054	28.078	28.101	28.124	28.148	1,240
1,250	28.148	28.171	28.195	28.218	28.241	28.265	28.288	28.311	28.335	28.358	28.382	1,250
1,260	28.382	28.405	28.428	28.452	28.475	28.498	28.522	28.545	28.569	28.592	28.615	1,260
1,270	28.615	28.639	28.662	28.685	28.709	28.732	28.755	28.779	28.802	28.825	28.849	1,270
1,280	28.849	28.872	28.895	28.919	28.942	28.965	28.988	29.012	29.035	29.058	29.082	1,280
1,290	29.082	29.105	29.128	29.152	29.175	29.198	29.221	29.245	29.268	29.291	29.315	1,290
1,300	29.315	29.338	29.361	29.384	29.408	29.431	29.454	29.477	29.501	29.524	29.547	1,300
1,310	29.547	29.570	29.594	29.617	29.640	29.663	29.687	29.710	29.733	29.756	29.780	1,310
1,320	29.780	29.803	29.826	29.849	29.872	29.896	29.919	29.942	29.965	29.989	30.012	1,320
1,330	30.012	30.035	30.058	30.081	30.104	30.128	30.151	30.174	30.197	30.220	30.244	1,330
1,340	30.244	30.267	30.290	30.313	30.336	30.359	30.383	30.406	30.429	30.452	30.475	1,340
1,350	30.475	30.498	30.521	30.545	30.568	30.591	30.614	30.637	30.660	30.683	30.706	1,350
1,360	30.706	30.730	30.753	30.776	30.799	30.822	30.845	30.868	30.891	30.914	30.937	1,360
1,370	30.937	30.961	30.984	31.007	31.030	31.053	31.076	31.099	31.122	31.145	31.168	1,370
1,380	31.168	31.191	31.214	31.237	31.260	31.283	31.306	31.329	31.353	31.376	31.399	1,380
1,390	31.399	31.422	31.445	31.468	31.491	31.514	31.537	31.560	31.583	31.606	31.629	1,390
1,400	31.629	31.652	31.675	31.698	31.721	31.744	31.767	31.790	31.813	31.836	31.859	1,400
1,410	31.859	31.882	31.905	31.927	31.950	31.973	31.996	32.019	32.042	32.065	32.088	1,410
1,420	32.088	32.111	32.134	32.157	32.180	32.203	32.226	32.249	32.272	32.294	32.317	1,420
1,430	32.317	32.340	32.363	32.386	32.409	32.432	32.455	32.478	32.501	32.523	32.546	1,430
1,440	32.546	32.569	32.592	32.615	32.638	32.661	32.683	32.706	32.729	32.752	32.775	1,440
1,450	32.775	32.798	32.821	32.843	32.866	32.889	32.912	32.935	32.958	32.980	33.003	1,450
1,460	33.003	33.026	33.049	33.072	33.094	33.117	33.140	33.163	33.186	33.208	33.231	1,460
1,470	33.231	33.254	33.277	33.300	33.322	33.345	33.368	33.391	33.413	33.436	33.459	1,470
1,480	33.459	33.482	33.504	33.527	33.550	33.573	33.595	33.618	33.641	33.664	33.686	1,480
1,490	33.686	33.709	33.732	33.754	33.777	33.800	33.823	33.845	33.868	33.891	33.913	1,490
1,500	33.913	33.936	33.959	33.981	34.004	34.027	34.049	34.072	34.095	34.117	34.140	1,500
1,510	34.140	34.163	34.185	34.208	34.231	34.253	34.276	34.299	34.321	34.344	34.366	1,510
1,520	34.366	34.389	34.412	34.434	34.457	34.480	34.502	34.525	34.547	34.570	34.593	1,520
1,530	34.593	34.615	34.638	34.660	34.683	34.705	34.728	34.751	34.773	34.796	34.818	1,530
1,540	34.818	34.841	34.863	34.886	34.909	34.931	34.954	34.976	34.999	35.021	35.044	1,540
DEG F	0	1	2	3	4	5	6	7	8	9	10	DEG F

* CONVERTED FROM DEGREES C(IPTS 1968).

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*Equivalent material now available from other manufacturers. See "Trade Names of Alloys" table on page **T-38**

OMEGA
ENGINEERING, INC.
An OMEGA Group Company
One Omega Drive, Box 4047, Stamford, CT 06907
(203) 359-1660 Telex 996404 Cable OMEGA

TABLE IX — Continued

TYPE K

New Reference Tables
Supersedes N.B.S.
Circular #561

Nickel-Chromium Vs. Nickel-Aluminum

(Chromel-Alumel)*

Temperature in Degrees F
Reference Junction at 32°F

THERMOELECTRIC VOLTAGE IN ABSOLUTE MILLIVOLTS

DEG F	0	1	2	3	4	5	6	7	8	9	10	DEG F
1,550	35.044	35.066	35.089	35.111	35.134	35.156	35.179	35.201	35.224	35.246	35.269	1,550
1,560	35.269	35.291	35.314	35.336	35.359	35.381	35.404	35.426	35.449	35.471	35.494	1,560
1,570	35.494	35.516	35.539	35.561	35.583	35.606	35.628	35.651	35.673	35.696	35.718	1,570
1,580	35.718	35.741	35.763	35.785	35.808	35.830	35.853	35.875	35.897	35.920	35.942	1,580
1,590	35.942	35.965	35.987	36.009	36.032	36.054	36.077	36.099	36.121	36.144	36.166	1,590
1,600	36.166	36.188	36.211	36.233	36.256	36.278	36.300	36.323	36.345	36.367	36.390	1,600
1,610	36.390	36.412	36.434	36.457	36.479	36.501	36.524	36.546	36.568	36.590	36.613	1,610
1,620	36.613	36.635	36.657	36.680	36.702	36.724	36.746	36.769	36.791	36.813	36.836	1,620
1,630	36.836	36.858	36.880	36.902	36.925	36.947	36.969	36.991	37.014	37.036	37.058	1,630
1,640	37.058	37.080	37.103	37.125	37.147	37.169	37.191	37.214	37.236	37.258	37.280	1,640
1,650	37.280	37.303	37.325	37.347	37.369	37.391	37.413	37.436	37.458	37.480	37.502	1,650
1,660	37.502	37.524	37.547	37.569	37.591	37.613	37.635	37.657	37.679	37.702	37.724	1,660
1,670	37.724	37.746	37.768	37.790	37.812	37.834	37.857	37.879	37.901	37.923	37.945	1,670
1,680	37.945	37.967	37.989	38.011	38.033	38.055	38.078	38.100	38.122	38.144	38.166	1,680
1,690	38.166	38.188	38.210	38.232	38.254	38.276	38.298	38.320	38.342	38.364	38.387	1,690
1,700	38.387	38.409	38.431	38.453	38.475	38.497	38.519	38.541	38.563	38.585	38.607	1,700
1,710	38.607	38.629	38.651	38.673	38.695	38.717	38.739	38.761	38.783	38.805	38.827	1,710
1,720	38.827	38.849	38.871	38.893	38.915	38.937	38.959	38.981	39.003	39.024	39.046	1,720
1,730	39.046	39.068	39.090	39.112	39.134	39.156	39.178	39.200	39.222	39.244	39.266	1,730
1,740	39.266	39.288	39.310	39.331	39.353	39.375	39.397	39.419	39.441	39.463	39.485	1,740
1,750	39.485	39.507	39.529	39.550	39.572	39.594	39.616	39.638	39.660	39.682	39.703	1,750
1,760	39.703	39.725	39.747	39.769	39.791	39.813	39.835	39.856	39.878	39.900	39.922	1,760
1,770	39.922	39.944	39.965	39.987	40.009	40.031	40.053	40.075	40.096	40.118	40.140	1,770
1,780	40.140	40.162	40.183	40.205	40.227	40.249	40.271	40.292	40.314	40.336	40.358	1,780
1,790	40.358	40.379	40.401	40.423	40.445	40-466	40.488	40.510	40.532	40.553	40.575	1,790
1,800	40.575	40.597	40.619	40.640	40.662	40.684	40.705	40.727	40.749	40.770	40.792	1,800
1,810	40.792	40.814	40.836	40.857	40.879	40.901	40.922	40.944	40.966	40.987	41.009	1,810
1,820	41.009	41.031	41.052	41.074	41.096	41.117	41.139	41.161	41.182	41.204	41.225	1,820
1,830	41.225	41.247	41.269	41.290	41.312	41.334	41.355	41.377	41.398	41.420	41.442	1,830
1,840	41.442	41.463	41.485	41.506	41.528	41.550	41.571	41.593	41.614	41.636	41.657	1,840
1,850	41.657	41.679	41.701	41.722	41.744	41.765	41.787	41.808	41.830	41.851	41.873	1,850
1,860	41.873	41.895	41.916	41.938	41.959	41.981	42.002	42.024	42.045	42.067	42.088	1,860
1,870	42.088	42.110	42.131	42.153	42.174	42.196	42.217	42.239	42.260	42.282	42.303	1,870
1,880	42.303	42.325	42.346	42.367	42.389	42.410	42.432	42.453	42.475	42.496	42.518	1,880
1,890	42.518	42.539	42.560	42.582	42.603	42.625	42.646	42.668	42.689	42.710	42.732	1,890
1,900	42.732	42.753	42.775	42.796	42.817	42.839	42.860	42.882	42.903	42.924	42.946	1,900
1,910	42.946	42.967	42.989	43.010	43.031	43.053	43.074	43.095	43.117	43.138	43.159	1,910
1,920	43.159	43.181	43.202	43.223	43.245	43.266	43.287	43.309	43.330	43.351	43.373	1,920
1,930	43.373	43.394	43.415	43.436	43.458	43.479	43.500	43.522	43.543	43.564	43.585	1,930
1,940	43.585	43.607	43.628	43.649	43.671	43.692	43.713	43.734	43.756	43.777	43.798	1,940
1,950	43.798	43.819	43.841	43.862	43.883	43.904	43.925	43.947	43.968	43.989	44.010	1,950
1,960	44.010	44.031	44.053	44.074	44.095	44.116	44.137	44.159	44.180	44.201	44.222	1,960
1,970	44.222	44.243	44.265	44.286	44.307	44.328	44.349	44.370	44.391	44.413	44.434	1,970
1,980	44.434	44.455	44.476	44.497	44.518	44.539	44.560	44.582	44.603	44.624	44.645	1,980
1,990	44.645	44.666	44.687	44.708	44.729	44.750	44.771	44.793	44.814	44.835	44.856	1,990
2,000	44.856	44.877	44.898	44.919	44.940	44.961	44.982	45.003	45.024	45.045	45.066	2,000
2,010	45.066	45.087	45.108	45.129	45.150	45.171	45.192	45.213	45.234	45.255	45.276	2,010
2,020	45.276	45.297	45.318	45.339	45.360	45.381	45.402	45.423	45.444	45.465	45.486	2,020
2,030	45.486	45.507	45.528	45.549	45.570	45.591	45.612	45.633	45.654	45.675	45.695	2,030
2,040	45.695	45.716	45.737	45.758	45.779	45.800	45.821	45.842	45.863	45.884	45.904	2,040
2,050	45.904	45.925	45.946	45.967	45.988	46.009	46.030	46.051	46.071	46.092	46.113	2,050
2,060	46.113	46.134	46.155	46.176	46.196	46.217	46.238	46.259	46.280	46.300	46.321	2,060
2,070	46.321	46.342	46.363	46.384	46.404	46.425	46.446	46.467	46.488	46.508	46.529	2,070
2,080	46.529	46.550	46.571	46.591	46.612	46.633	46.654	46.674	46.695	46.716	46.737	2,080
2,090	46.737	46.757	46.778	46.799	46.819	46.840	46.861	46.881	46.902	46.923	46.944	2,090
2,100	46.944	46.964	46.985	47.006	47.026	47.047	47.068	47.088	47.109	47.130	47.150	2,100
2,110	47.150	47.171	47.191	47.212	47.233	47.253	47.274	47.295	47.315	47.336	47.356	2,110
2,120	47.356	47.377	47.398	47.418	47.439	47.459	47.480	47.500	47.521	47.542	47.562	2,120
2,130	47.562	47.583	47.603	47.624	47.644	47.665	47.685	47.706	47.726	47.747	47.767	2,130
2,140	47.767	47.788	47.808	47.829	47.849	47.870	47.890	47.911	47.931	47.952	47.972	2,140
2,150	47.972	47.993	48.013	48.034	48.054	48.075	48.095	48.116	48.136	48.156	48.177	2,150
2,160	48.177	48.197	48.218	48.238	48.258	48.279	48.299	48.320	48.340	48.360	48.381	2,160
2,170	48.381	48.401	48.422	48.442	48.462	48.483	48.503	48.523	48.544	48.564	48.584	2,170
2,180	48.584	48.605	48.625	48.645	48.666	48.686	48.706	48.727	48.747	48.767	48.787	2,180
2,190	48.787	48.808	48.828	48.848	48.869	48.889	48.909	48.929	48.950	48.970	48.990	2,190
2,200	48.990	49.010	49.031	49.051	49.071	49.091	49.111	49.132	49.152	49.172	49.192	2,200
2,210	49.192	49.212	49.233	49.253	49.273	49.293	49.313	49.333	49.354	49.374	49.394	2,210
2,220	49.394	49.414	49.434	49.454	49.474	49.495	49.515	49.535	49.555	49.575	49.595	2,220
2,230	49.595	49.615	49.635	49.655	49.675	49.696	49.716	49.736	49.756	49.776	49.796	2,230
2,240	49.796	49.816	49.836	49.856	49.876	49.896	49.916	49.936	49.956	49.976	49.996	2,240
2,250	49.996	50.016	50.036	50.056	50.076	50.096	50.116	50.136	50.156	50.176	50.196	2,250
2,260	50.196	50.216	50.236	50.256	50.276	50.296	50.315	50.335	50.355	50.375	50.395	2,260
2,270	50.395	50.415	50.435	50.455	50.475	50.494	50.514	50.534	50.554	50.574	50.594	2,270
2,280	50.594	50.614	50.633	50.653	50.673	50.693	50.713	50.733	50.752	50.772	50.792	2,280
2,290	50.792	50.812	50.832	50.851	50.871	50.891	50.911	50.930	50.950	50.970	50.990	2,290
2,300	50.990	51.009	51.029	51.049	51.069	51.088	51.108	51.128	51.148	51.167	51.187	2,300
2,310	51.187	51.207	51.226	51.246	51.266	51.285	51.305	51.325	51.344	51.364	51.384	2,310
2,320	51.384	51.403	51.423	51.443	51.462	51.482	51.501	51.521	51.541	51.560	51.580	2,320
2,330	51.580	51.599	51.619	51.639	51.658	51.678	51.697	51.717	51.736	51.756	51.776	2,330
2,340	51.776	51.795	51.815	51.834	51.854	51.873	51.893	51.912	51.932	51.951	51.971	2,340
2,350	51.971	51.990	52.010	52.029	52.049	52.068	52.088	52.107	52.127	52.146	52.165	2,350
2,360	52.165	52.185	52.204	52.224	52.243	52.263	52.282	52.301	52.321	52.340	52.360	2,360
2,370	52.360	52.379	52.398	52.418	52.437	52.457	52.476	52.495	52.515	52.534	52.553	2,370
2,380	52.553	52.573	52.592	52.611	52.631	52.650	52.669	52.689	52.708	52.727	52.747	2,380
2,390	52.747	52.766	52.785	52.805	52.824	52.843	52.862	52.882	52.901	52.920	52.939	2,390
2,400	52.939	52.959	52.978	52.997	53.016	53.036	53.055	53.074	53.093	53.113	53.132	2,400
2,410	53.132	53.151	53.170	53.189	53.209	53.228	53.247	53.266	53.285	53.304	53.324	2,410
2,420	53.324	53.343	53.362	53.381	53.400	53.419	53.439	53.458	53.477	53.496	53.515	2,420
2,430	53.515	53.534	53.553	53.572	53.592	53.611	53.630	53.649	53.668	53.687	53.706	2,430
2,440	53.706	53.725	53.744	53.763	53.782	53.801	53.821	53.840	53.859	53.878	53.897	2,440
2,450	53.897	53.916	53.935	53.954	53.973	53.992	54.011	54.030	54.049	54.068	54.087	2,450
2,460	54.087	54.106	54.125	54.144	54.163	54.182	54.201	54.220	54.239	54.258	54.277	2,460
2,470	54.277	54.296	54.315	54.334	54.353	54.372	54.391	54.410	54.429	54.447	54.466	2,470
2,480	54.466	54.485	54.504	54.523	54.542	54.561	54.580	54.599	54.618	54.637	54.656	2,480
2,490	54.656	54.675	54.694	54.712	54.731	54.750	54.769	54.788	54.807	54.826	54.845	2,490
2,500	54.845											2,500
DEG F	0	1	2	3	4	5	6	7	8	9	10	DEG F

* CONVERTED FROM DEGREES C(IPTS 1968).

*Equivalent material now available from other manufacturers. See "Trade Names of Alloys" table on page **T-38**

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OMEGA
ENGINEERING, INC.
An OMEGA Group Company
One Omega Drive, Box 4047, Stamford, CT 06907
(203) 359-1660 Telex 996404 Cable OMEGA

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TABLE X

TYPE E

New Reference Tables
Supersedes N.B.S.
Circular #561

Nickel-Chromium Vs. Copper-Nickel

(Chromel-Constantan)

Temperature in Degrees F
Reference Junction at 32°F

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THERMOELECTRIC VOLTAGE IN ABSOLUTE MILLIVOLTS

DEG F	0	1	2	3	4	5	6	7	8	9	10	DEG F
-450	-9.830	-9.832	-9.833	-9.834	-9.835							-450
-440	-9.809	-9.812	-9.814	-9.817	-9.819	-9.821	-9.823	-9.825	-9.827	-9.829	-9.830	-440
-430	-9.775	-9.779	-9.783	-9.786	-9.790	-9.793	-9.797	-9.800	-9.803	-9.806	-9.809	-430
-420	-9.729	-9.734	-9.739	-9.744	-9.749	-9.753	-9.758	-9.762	-9.767	-9.771	-9.775	-420
-410	-9.672	-9.678	-9.684	-9.690	-9.696	-9.702	-9.708	-9.713	-9.719	-9.724	-9.729	-410
-400	-9.604	-9.611	-9.619	-9.626	-9.633	-9.639	-9.646	-9.653	-9.659	-9.666	-9.672	-400
-390	-9.526	-9.534	-9.542	-9.550	-9.558	-9.566	-9.574	-9.582	-9.589	-9.597	-9.604	-390
-380	-9.437	-9.446	-9.455	-9.464	-9.473	-9.482	-9.491	-9.500	-9.509	-9.517	-9.526	-380
-370	-9.338	-9.348	-9.358	-9.368	-9.378	-9.388	-9.398	-9.408	-9.418	-9.427	-9.437	-370
-360	-9.229	-9.241	-9.252	-9.263	-9.274	-9.285	-9.296	-9.306	-9.317	-9.327	-9.338	-360
-350	-9.112	-9.124	-9.136	-9.148	-9.160	-9.172	-9.184	-9.195	-9.207	-9.218	-9.229	-350
-340	-8.986	-8.999	-9.012	-9.025	-9.038	-9.050	-9.063	-9.075	-9.088	-9.100	-9.112	-340
-330	-8.852	-8.866	-8.880	-8.893	-8.907	-8.920	-8.934	-8.947	-8.960	-8.973	-8.986	-330
-320	-8.710	-8.725	-8.739	-8.754	-8.768	-8.782	-8.796	-8.810	-8.824	-8.838	-8.852	-320
-310	-8.561	-8.576	-8.591	-8.606	-8.621	-8.636	-8.651	-8.666	-8.681	-8.696	-8.710	-310
-300	-8.404	-8.420	-8.436	-8.452	-8.468	-8.483	-8.499	-8.514	-8.530	-8.545	-8.561	-300
-290	-8.240	-8.257	-8.273	-8.290	-8.306	-8.323	-8.339	-8.355	-8.372	-8.388	-8.404	-290
-280	-8.069	-8.086	-8.104	-8.121	-8.138	-8.155	-8.172	-8.189	-8.206	-8.223	-8.240	-280
-270	-7.891	-7.909	-7.927	-7.945	-7.963	-7.981	-7.999	-8.016	-8.034	-8.051	-8.069	-270
-260	-7.707	-7.726	-7.744	-7.763	-7.781	-7.800	-7.818	-7.837	-7.855	-7.873	-7.891	-260
-250	-7.516	-7.535	-7.555	-7.574	-7.593	-7.612	-7.631	-7.650	-7.669	-7.688	-7.707	-250
-240	-7.319	-7.339	-7.359	-7.379	-7.399	-7.418	-7.438	-7.458	-7.477	-7.497	-7.516	-240
-230	-7.116	-7.137	-7.157	-7.178	-7.198	-7.218	-7.239	-7.259	-7.279	-7.299	-7.319	-230
-220	-6.907	-6.928	-6.949	-6.970	-6.991	-7.012	-7.033	-7.054	-7.075	-7.095	-7.116	-220
-210	-6.692	-6.714	-6.735	-6.757	-6.779	-6.800	-6.822	-6.843	-6.864	-6.886	-6.907	-210
-200	-6.471	-6.494	-6.516	-6.538	-6.560	-6.582	-6.604	-6.626	-6.648	-6.670	-6.692	-200
-190	-6.245	-6.268	-6.291	-6.314	-6.336	-6.359	-6.382	-6.404	-6.427	-6.449	-6.471	-190
-180	-6.013	-6.037	-6.060	-6.084	-6.107	-6.130	-6.153	-6.176	-6.199	-6.222	-6.245	-180
-170	-5.776	-5.800	-5.824	-5.848	-5.872	-5.896	-5.919	-5.943	-5.967	-5.990	-6.013	-170
-160	-5.534	-5.559	-5.583	-5.607	-5.632	-5.656	-5.680	-5.704	-5.728	-5.752	-5.776	-160
-150	-5.287	-5.312	-5.337	-5.362	-5.386	-5.411	-5.436	-5.460	-5.485	-5.510	-5.534	-150
-140	-5.034	-5.060	-5.085	-5.111	-5.136	-5.161	-5.186	-5.212	-5.237	-5.262	-5.287	-140
-130	-4.777	-4.803	-4.829	-4.855	-4.880	-4.906	-4.932	-4.958	-4.983	-5.009	-5.034	-130
-120	-4.515	-4.541	-4.567	-4.594	-4.620	-4.646	-4.672	-4.699	-4.725	-4.751	-4.777	-120
-110	-4.248	-4.274	-4.301	-4.328	-4.355	-4.382	-4.408	-4.435	-4.462	-4.488	-4.515	-110
-100	-3.976	-4.003	-4.031	-4.058	-4.085	-4.112	-4.139	-4.167	-4.194	-4.221	-4.248	-100
-90	-3.700	-3.728	-3.755	-3.783	-3.811	-3.838	-3.866	-3.894	-3.921	-3.949	-3.976	-90
-80	-3.419	-3.447	-3.476	-3.504	-3.532	-3.560	-3.588	-3.616	-3.644	-3.672	-3.700	-80
-70	-3.134	-3.163	-3.192	-3.220	-3.249	-3.277	-3.306	-3.334	-3.363	-3.391	-3.419	-70
-60	-2.845	-2.874	-2.903	-2.932	-2.961	-2.990	-3.019	-3.048	-3.077	-3.106	-3.134	-60
-50	-2.552	-2.581	-2.611	-2.640	-2.670	-2.699	-2.728	-2.758	-2.787	-2.816	-2.845	-50
-40	-2.254	-2.284	-2.314	-2.344	-2.374	-2.404	-2.433	-2.463	-2.493	-2.522	-2.552	-40
-30	-1.953	-1.983	-2.014	-2.044	-2.074	-2.104	-2.134	-2.164	-2.194	-2.224	-2.254	-30
-20	-1.648	-1.678	-1.709	-1.740	-1.770	-1.801	-1.831	-1.862	-1.892	-1.923	-1.953	-20
-10	-1.339	-1.370	-1.401	-1.432	-1.463	-1.494	-1.525	-1.555	-1.586	-1.617	-1.648	-10
0	-1.026	-1.057	-1.089	-1.120	-1.151	-1.183	-1.214	-1.245	-1.276	-1.308	-1.339	0

DEG F	0	1	2	3	4	5	6	7	8	9	10	DEG F
0	-1.026	-0.994	-0.963	-0.931	-0.900	-0.868	-0.836	-0.805	-0.773	-0.741	-0.709	0
10	-0.709	-0.677	-0.645	-0.613	-0.581	-0.549	-0.517	-0.485	-0.453	-0.421	-0.389	10
20	-0.389	-0.357	-0.324	-0.292	-0.260	-0.227	-0.195	-0.163	-0.130	-0.098	-0.065	20
30	-0.065	-0.033	0.000	0.033	0.065	0.098	0.131	0.163	0.196	0.229	0.262	30
40	0.262	0.295	0.327	0.360	0.393	0.426	0.459	0.492	0.525	0.558	0.591	40
50	0.591	0.624	0.658	0.691	0.724	0.757	0.790	0.824	0.857	0.890	0.924	50
60	0.924	0.957	0.990	1.024	1.057	1.091	1.124	1.158	1.192	1.225	1.259	60
70	1.259	1.292	1.326	1.360	1.394	1.427	1.461	1.495	1.529	1.563	1.597	70
80	1.597	1.631	1.665	1.699	1.733	1.767	1.801	1.835	1.869	1.903	1.937	80
90	1.937	1.972	2.006	2.040	2.075	2.109	2.143	2.178	2.212	2.247	2.281	90
100	2.281	2.316	2.350	2.385	2.419	2.454	2.489	2.523	2.558	2.593	2.627	100
110	2.627	2.662	2.697	2.732	2.767	2.802	2.837	2.872	2.907	2.942	2.977	110
120	2.977	3.012	3.047	3.082	3.117	3.152	3.187	3.223	3.258	3.293	3.329	120
130	3.329	3.364	3.399	3.435	3.470	3.506	3.541	3.577	3.612	3.648	3.683	130
140	3.683	3.719	3.755	3.790	3.826	3.862	3.898	3.933	3.969	4.005	4.041	140
150	4.041	4.077	4.113	4.149	4.185	4.221	4.257	4.293	4.329	4.365	4.401	150
160	4.401	4.437	4.474	4.510	4.546	4.582	4.619	4.655	4.691	4.728	4.764	160
170	4.764	4.801	4.837	4.874	4.910	4.947	4.983	5.020	5.056	5.093	5.130	170
180	5.130	5.166	5.203	5.240	5.277	5.314	5.350	5.387	5.424	5.461	5.498	180
190	5.498	5.535	5.572	5.609	5.646	5.683	5.720	5.757	5.794	5.832	5.869	190
200	5.869	5.906	5.943	5.981	6.018	6.055	6.092	6.130	6.167	6.205	6.242	200
210	6.242	6.280	6.317	6.355	6.392	6.430	6.467	6.505	6.543	6.580	6.618	210
220	6.618	6.656	6.693	6.731	6.769	6.807	6.845	6.882	6.920	6.958	6.996	220
230	6.996	7.034	7.072	7.110	7.148	7.186	7.224	7.262	7.300	7.339	7.377	230
240	7.377	7.415	7.453	7.491	7.530	7.568	7.606	7.645	7.683	7.721	7.760	240
250	7.760	7.798	7.837	7.875	7.914	7.952	7.991	8.029	8.068	8.106	8.145	250
260	8.145	8.184	8.222	8.261	8.300	8.338	8.377	8.416	8.455	8.494	8.532	260
270	8.532	8.571	8.610	8.649	8.688	8.727	8.766	8.805	8.844	8.883	8.922	270
280	8.922	8.961	9.000	9.039	9.078	9.118	9.157	9.196	9.235	9.274	9.314	280
290	9.314	9.353	9.392	9.432	9.471	9.510	9.550	9.589	9.629	9.668	9.708	290
300	9.708	9.747	9.787	9.826	9.866	9.905	9.945	9.984	10.024	10.064	10.103	300
310	10.103	10.143	10.183	10.223	10.262	10.302	10.342	10.382	10.421	10.461	10.501	310
320	10.501	10.541	10.581	10.621	10.661	10.701	10.741	10.781	10.821	10.861	10.901	320
330	10.901	10.941	10.981	11.021	11.061	11.101	11.142	11.182	11.222	11.262	11.302	330
340	11.302	11.343	11.383	11.423	11.464	11.504	11.544	11.585	11.625	11.665	11.706	340
350	11.706	11.746	11.787	11.827	11.868	11.908	11.949	11.989	12.030	12.070	12.111	350
360	12.111	12.152	12.192	12.233	12.273	12.314	12.355	12.396	12.436	12.477	12.518	360
370	12.518	12.559	12.599	12.640	12.681	12.722	12.763	12.804	12.844	12.885	12.926	370
380	12.926	12.967	13.008	13.049	13.090	13.131	13.172	13.213	13.254	13.295	13.336	380
390	13.336	13.378	13.419	13.460	13.501	13.542	13.583	13.624	13.666	13.707	13.748	390
400	13.748	13.789	13.831	13.872	13.913	13.955	13.996	14.037	14.079	14.120	14.161	400
410	14.161	14.203	14.244	14.286	14.327	14.368	14.410	14.451	14.493	14.534	14.576	410
420	14.576	14.618	14.659	14.701	14.742	14.784	14.826	14.867	14.909	14.950	14.992	420
430	14.992	15.034	15.076	15.117	15.159	15.201	15.243	15.284	15.326	15.368	15.410	430
440	15.410	15.451	15.493	15.535	15.577	15.619	15.661	15.703	15.745	15.787	15.829	440
DEG F	0	1	2	3	4	5	6	7	8	9	10	DEG F

* CONVERTED FROM DEGREES C(IPTS 1968).

TABLE X — Continued

TYPE E

New Reference Tables
Supersedes N.B.S.
Circular #561

Nickel-Chromium Vs. Copper-Nickel

(Chromel-Constantan)

Temperature in Degrees F
Reference Junction at 32°F

THERMOELECTRIC VOLTAGE IN ABSOLUTE MILLIVOLTS

DEG F	0	1	2	3	4	5	6	7	8	9	10	DEG F
450	15.829	15.871	15.912	15.954	15.996	16.038	16.080	16.123	16.165	16.207	16.249	450
460	16.249	16.291	16.333	16.375	16.417	16.459	16.501	16.544	16.586	16.628	16.670	460
470	16.670	16.712	16.755	16.797	16.839	16.881	16.924	16.966	17.008	17.051	17.093	470
480	17.093	17.135	17.178	17.220	17.262	17.305	17.347	17.389	17.432	17.474	17.517	480
490	17.517	17.559	17.602	17.644	17.687	17.729	17.772	17.814	17.857	17.899	17.942	490
500	17.942	17.984	18.027	18.070	18.112	18.155	18.197	18.240	18.283	18.325	18.368	500
510	18.368	18.411	18.453	18.496	18.539	18.581	18.624	18.667	18.710	18.752	18.795	510
520	18.795	18.838	18.881	18.924	18.966	19.009	19.052	19.095	19.138	19.181	19.223	520
530	19.223	19.266	19.309	19.352	19.395	19.438	19.481	19.524	19.567	19.610	19.653	530
540	19.653	19.696	19.739	19.782	19.825	19.868	19.911	19.954	19.997	20.040	20.083	540
550	20.083	20.126	20.169	20.212	20.256	20.299	20.342	20.385	20.428	20.471	20.514	550
560	20.514	20.558	20.601	20.644	20.687	20.730	20.774	20.817	20.860	20.903	20.947	560
570	20.947	20.990	21.033	21.076	21.120	21.163	21.206	21.250	21.293	21.336	21.380	570
580	21.380	21.423	21.466	21.510	21.553	21.597	21.640	21.683	21.727	21.770	21.814	580
590	21.814	21.857	21.901	21.944	21.987	22.031	22.074	22.118	22.161	22.205	22.248	590
600	22.248	22.292	22.336	22.379	22.423	22.466	22.510	22.553	22.597	22.640	22.684	600
610	22.684	22.728	22.771	22.815	22.859	22.902	22.946	22.989	23.033	23.077	23.120	610
620	23.120	23.164	23.208	23.252	23.295	23.339	23.383	23.426	23.470	23.514	23.558	620
630	23.558	23.601	23.645	23.689	23.733	23.777	23.820	23.864	23.908	23.952	23.996	630
640	23.996	24.039	24.083	24.127	24.171	24.215	24.259	24.302	24.346	24.390	24.434	640
650	24.434	24.478	24.522	24.566	24.610	24.654	24.698	24.742	24.786	24.829	24.873	650
660	24.873	24.917	24.961	25.005	25.049	25.093	25.137	25.181	25.225	25.269	25.313	660
670	25.313	25.357	25.401	25.445	25.490	25.534	25.578	25.622	25.666	25.710	25.754	670
680	25.754	25.798	25.842	25.886	25.930	25.974	26.019	26.063	26.107	26.151	26.195	680
690	26.195	26.239	26.283	26.328	26.372	26.416	26.460	26.504	26.549	26.593	26.637	690
700	26.637	26.681	26.725	26.770	26.814	26.858	26.902	26.947	26.991	27.035	27.079	700
710	27.079	27.124	27.168	27.212	27.256	27.301	27.345	27.389	27.434	27.478	27.522	710
720	27.522	27.566	27.611	27.655	27.699	27.744	27.788	27.832	27.877	27.921	27.966	720
730	27.966	28.010	28.054	28.099	28.143	28.187	28.232	28.276	28.321	28.365	28.409	730
740	28.409	28.454	28.498	28.543	28.587	28.632	28.676	28.720	28.765	28.809	28.854	740
750	28.854	28.898	28.943	28.987	29.032	29.076	29.121	29.165	29.210	29.254	29.299	750
760	29.299	29.343	29.388	29.432	29.477	29.521	29.566	29.610	29.655	29.699	29.744	760
770	29.744	29.788	29.833	29.878	29.922	29.967	30.011	30.056	30.100	30.145	30.190	770
780	30.190	30.234	30.279	30.323	30.368	30.412	30.457	30.502	30.546	30.591	30.636	780
790	30.636	30.680	30.725	30.769	30.814	30.859	30.903	30.948	30.993	31.037	31.082	790
800	31.082	31.127	31.171	31.216	31.261	31.305	31.350	31.395	31.439	31.484	31.529	800
810	31.529	31.573	31.618	31.663	31.707	31.752	31.797	31.842	31.886	31.931	31.976	810
820	31.976	32.020	32.065	32.110	32.155	32.199	32.244	32.289	32.334	32.378	32.423	820
830	32.423	32.468	32.513	32.557	32.602	32.647	32.692	32.736	32.781	32.826	32.871	830
840	32.871	32.916	32.960	33.005	33.050	33.095	33.140	33.184	33.229	33.274	33.319	840
850	33.319	33.364	33.408	33.453	33.498	33.543	33.588	33.632	33.677	33.722	33.767	850
860	33.767	33.812	33.857	33.901	33.946	33.991	34.036	34.081	34.126	34.170	34.215	860
870	34.215	34.260	34.305	34.350	34.395	34.440	34.484	34.529	34.574	34.619	34.664	870
880	34.664	34.709	34.754	34.798	34.843	34.888	34.933	34.978	35.023	35.068	35.113	880
890	35.113	35.157	35.202	35.247	35.292	35.337	35.382	35.427	35.472	35.517	35.562	890
900	35.562	35.606	35.651	35.696	35.741	35.786	35.831	35.876	35.921	35.966	36.011	900
910	36.011	36.056	36.100	36.145	36.190	36.235	36.280	36.325	36.370	36.415	36.460	910
920	36.460	36.505	36.550	36.595	36.640	36.684	36.729	36.774	36.819	36.864	36.909	920
930	36.909	36.954	36.999	37.044	37.089	37.134	37.179	37.224	37.269	37.314	37.358	930
940	37.358	37.403	37.448	37.493	37.538	37.583	37.628	37.673	37.718	37.763	37.808	940
950	37.808	37.853	37.898	37.943	37.988	38.033	38.078	38.123	38.168	38.213	38.257	950
960	38.257	38.302	38.347	38.392	38.437	38.482	38.527	38.572	38.617	38.662	38.707	960
970	38.707	38.752	38.797	38.842	38.887	38.932	38.977	39.022	39.067	39.112	39.157	970
980	39.157	39.202	39.247	39.291	39.336	39.381	39.426	39.471	39.516	39.561	39.606	980
990	39.606	39.651	39.696	39.741	39.786	39.831	39.876	39.921	39.966	40.011	40.056	990
1,000	40.056	40.101	40.146	40.191	40.236	40.280	40.325	40.370	40.415	40.460	40.505	1,000
1,010	40.505	40.550	40.595	40.640	40.685	40.730	40.775	40.820	40.865	40.910	40.955	1,010
1,020	40.955	41.000	41.045	41.090	41.134	41.179	41.224	41.269	41.314	41.359	41.404	1,020
1,030	41.404	41.449	41.494	41.539	41.584	41.629	41.674	41.719	41.764	41.808	41.853	1,030
1,040	41.853	41.898	41.943	41.988	42.033	42.078	42.123	42.168	42.213	42.258	42.303	1,040
1,050	42.303	42.348	42.392	42.437	42.482	42.527	42.572	42.617	42.662	42.707	42.752	1,050
1,060	42.752	42.797	42.842	42.886	42.931	42.976	43.021	43.066	43.111	43.156	43.201	1,060
1,070	43.201	43.246	43.290	43.335	43.380	43.425	43.470	43.515	43.560	43.605	43.650	1,070
1,080	43.650	43.694	43.739	43.784	43.829	43.874	43.919	43.964	44.008	44.053	44.098	1,080
1,090	44.098	44.143	44.188	44.233	44.278	44.322	44.367	44.412	44.457	44.502	44.547	1,090
1,100	44.547	44.592	44.636	44.681	44.726	44.771	44.816	44.861	44.905	44.950	44.995	1,100
1,110	44.995	45.040	45.085	45.130	45.174	45.219	45.264	45.309	45.354	45.398	45.443	1,110
1,120	45.443	45.488	45.533	45.578	45.622	45.667	45.712	45.757	45.802	45.846	45.891	1,120
1,130	45.891	45.936	45.981	46.025	46.070	46.115	46.160	46.205	46.249	46.294	46.339	1,130
1,140	46.339	46.384	46.428	46.473	46.518	46.563	46.607	46.652	46.697	46.742	46.786	1,140
1,150	46.786	46.831	46.876	46.921	46.965	47.010	47.055	47.099	47.144	47.189	47.234	1,150
1,160	47.234	47.278	47.323	47.368	47.412	47.457	47.502	47.546	47.591	47.636	47.681	1,160
1,170	47.681	47.725	47.770	47.815	47.859	47.904	47.949	47.993	48.038	48.083	48.127	1,170
1,180	48.127	48.172	48.217	48.261	48.306	48.351	48.395	48.440	48.484	48.529	48.574	1,180
1,190	48.574	48.618	48.663	48.708	48.752	48.797	48.842	48.886	48.931	48.975	49.020	1,190
1,200	49.020	49.065	49.109	49.154	49.198	49.243	49.288	49.332	49.377	49.421	49.466	1,200
1,210	49.466	49.510	49.555	49.600	49.644	49.689	49.733	49.778	49.822	49.867	49.911	1,210
1,220	49.911	49.956	50.001	50.045	50.090	50.134	50.179	50.223	50.268	50.312	50.357	1,220
1,230	50.357	50.401	50.446	50.490	50.535	50.579	50.624	50.668	50.713	50.757	50.802	1,230
1,240	50.802	50.846	50.891	50.935	50.980	51.024	51.069	51.113	51.157	51.202	51.246	1,240
1,250	51.246	51.291	51.335	51.380	51.424	51.469	51.513	51.557	51.602	51.646	51.691	1,250
1,260	51.691	51.735	51.780	51.824	51.868	51.913	51.957	52.002	52.046	52.090	52.135	1,260
1,270	52.135	52.179	52.223	52.268	52.312	52.357	52.401	52.445	52.490	52.534	52.578	1,270
1,280	52.578	52.623	52.667	52.711	52.756	52.800	52.844	52.889	52.933	52.977	53.022	1,280
1,290	53.022	53.066	53.110	53.155	53.199	53.243	53.288	53.332	53.376	53.420	53.465	1,290
1,300	53.465	53.509	53.553	53.597	53.642	53.686	53.730	53.774	53.819	53.863	53.907	1,300
1,310	53.907	53.951	53.996	54.040	54.084	54.128	54.173	54.217	54.261	54.305	54.349	1,310
1,320	54.349	54.394	54.438	54.482	54.526	54.570	54.615	54.659	54.703	54.747	54.791	1,320
1,330	54.791	54.835	54.880	54.924	54.968	55.012	55.056	55.100	55.145	55.189	55.233	1,330
1,340	55.233	55.277	55.321	55.365	55.409	55.453	55.498	55.542	55.586	55.630	55.674	1,340
1,350	55.674	55.718	55.762	55.806	55.850	55.894	55.938	55.982	56.026	56.071	56.115	1,350
1,360	56.115	56.159	56.203	56.247	56.291	56.335	56.379	56.423	56.467	56.511	56.555	1,360
1,370	56.555	56.599	56.643	56.687	56.731	56.775	56.819	56.863	56.907	56.951	56.995	1,370
1,380	56.995	57.039	57.083	57.127	57.171	57.215	57.259	57.303	57.346	57.390	57.434	1,380
1,390	57.434	57.478	57.522	57.566	57.610	57.654	57.698	57.742	57.786	57.830	57.873	1,390
DEG F	0	1	2	3	4	5	6	7	8	9	10	DEG F

* CONVERTED FROM DEGREES C(IPTS 1968).

OMEGA
ENGINEERING, INC.
An OMEGA Group Company
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TABLE X — Continued

TYPE E

New Reference Tables
Supersedes N.B.S.
Circular #561

Temperature in Degrees F
Reference Junction at 32°F

THERMOELECTRIC VOLTAGE IN ABSOLUTE MILLIVOLTS

DEG F	0	1	2	3	4	5	6	7	8	9	10	DEG F
1,400	57.873	57.917	57.961	58.005	58.049	58.093	58.137	58.181	58.224	58.268	58.312	1,400
1,410	58.312	58.356	58.400	58.444	58.487	58.531	58.575	58.619	58.663	58.707	58.750	1,410
1,420	58.750	58.794	58.838	58.882	58.926	58.969	59.013	59.057	59.101	59.144	59.188	1,420
1,430	59.188	59.232	59.276	59.319	59.363	59.407	59.451	59.494	59.538	59.582	59.626	1,430
1,440	59.626	59.669	59.713	59.757	59.800	59.844	59.888	59.932	59.975	60.019	60.063	1,440
1,450	60.063	60.106	60.150	60.194	60.237	60.281	60.325	60.368	60.412	60.455	60.499	1,450
1,460	60.499	60.543	60.586	60.630	60.674	60.717	60.761	60.804	60.848	60.892	60.935	1,460
1,470	60.935	60.979	61.022	61.066	61.109	61.153	61.197	61.240	61.284	61.327	61.371	1,470
1,480	61.371	61.414	61.458	61.501	61.545	61.588	61.632	61.675	61.719	61.762	61.806	1,480
1,490	61.806	61.849	61.893	61.936	61.980	62.023	62.067	62.110	62.154	62.197	62.240	1,490
1,500	62.240	62.284	62.327	62.371	62.414	62.458	62.501	62.544	62.588	62.631	62.675	1,500
1,510	62.675	62.718	62.761	62.805	62.848	62.892	62.935	62.978	63.022	63.065	63.108	1,510
1,520	63.108	63.152	63.195	63.238	63.282	63.325	63.368	63.412	63.455	63.498	63.542	1,520
1,530	63.542	63.585	63.628	63.671	63.715	63.758	63.801	63.844	63.888	63.931	63.974	1,530
1,540	63.974	64.017	64.061	64.104	64.147	64.190	64.234	64.277	64.320	64.363	64.406	1,540
1,550	64.406	64.450	64.493	64.536	64.579	64.622	64.665	64.709	64.752	64.795	64.838	1,550
1,560	64.838	64.881	64.924	64.967	65.011	65.054	65.097	65.140	65.183	65.226	65.269	1,560
1,570	65.269	65.312	65.355	65.398	65.441	65.484	65.528	65.571	65.614	65.657	65.700	1,570
1,580	65.700	65.743	65.786	65.829	65.872	65.915	65.958	66.001	66.044	66.087	66.130	1,580
1,590	66.130	66.173	66.216	66.259	66.302	66.345	66.387	66.430	66.473	66.516	66.559	1,590
1,600	66.559	66.602	66.645	66.688	66.731	66.774	66.817	66.859	66.902	66.945	66.988	1,600
1,610	66.988	67.031	67.074	67.117	67.159	67.202	67.245	67.288	67.331	67.374	67.416	1,610
1,620	67.416	67.459	67.502	67.545	67.588	67.630	67.673	67.716	67.759	67.801	67.844	1,620
1,630	67.844	67.887	67.930	67.972	68.015	68.058	68.101	68.143	68.186	68.229	68.271	1,630
1,640	68.271	68.314	68.357	68.399	68.442	68.485	68.527	68.570	68.613	68.655	68.698	1,640
1,650	68.698	68.740	68.783	68.826	68.868	68.911	68.953	68.996	69.039	69.081	69.124	1,650
1,660	69.124	69.166	69.209	69.251	69.294	69.337	69.379	69.422	69.464	69.507	69.549	1,660
1,670	69.549	69.592	69.634	69.677	69.719	69.762	69.804	69.847	69.889	69.931	69.974	1,670
1,680	69.974	70.016	70.059	70.101	70.144	70.186	70.228	70.271	70.313	70.356	70.398	1,680
1,690	70.398	70.440	70.483	70.525	70.567	70.610	70.652	70.694	70.737	70.779	70.821	1,690
1,700	70.821	70.864	70.906	70.948	70.991	71.033	71.075	71.118	71.160	71.202	71.244	1,700
1,710	71.244	71.287	71.329	71.371	71.413	71.456	71.498	71.540	71.582	71.624	71.667	1,710
1,720	71.667	71.709	71.751	71.793	71.835	71.878	71.920	71.962	72.004	72.046	72.088	1,720
1,730	72.088	72.130	72.173	72.215	72.257	72.299	72.341	72.383	72.425	72.467	72.509	1,730
1,740	72.509	72.551	72.593	72.635	72.678	72.720	72.762	72.804	72.846	72.888	72.930	1,740
1,750	72.930	72.972	73.014	73.056	73.098	73.140	73.182	73.224	73.266	73.308	73.350	1,750
1,760	73.350	73.392	73.434	73.475	73.517	73.559	73.601	73.643	73.685	73.727	73.769	1,760
1,770	73.769	73.811	73.853	73.895	73.936	73.978	74.020	74.062	74.104	74.146	74.188	1,770
1,780	74.188	74.229	74.271	74.313	74.355	74.397	74.439	74.480	74.522	74.564	74.606	1,780
1,790	74.606	74.648	74.689	74.731	74.773	74.815	74.857	74.898	74.940	74.982	75.024	1,790
1,800	75.024	75.065	75.107	75.149	75.191	75.232	75.274	75.316	75.357	75.399	75.441	1,800
1,810	75.441	75.483	75.524	75.566	75.608	75.649	75.691	75.733	75.774	75.816	75.858	1,810
1,820	75.858	75.899	75.941	75.983	76.024	76.066	76.108	76.149	76.191	76.233	76.274	1,820
1,830	76.274	76.316	76.358									1,830
DEG F	0	1	2	3	4	5	6	7	8	9	10	DEG F

* CONVERTED FROM DEGREES C(IPTS 1968).

TABLE XI

TYPE T

New Reference Tables
Supersedes N.B.S.
Circular #561

Copper Vs. Copper-Nickel

(Copper-Constantan)

THERMOELECTRIC VOLTAGE IN ABSOLUTE MILLIVOLTS

DEG F	0	1	2	3	4	5	6	7	8	9	10	DEG F
-450	-6.254	-6.255	-6.256	-6.257	-6.258							-450
-440	-6.240	-6.242	-6.243	-6.245	-6.247	-6.248	-6.250	-6.251	-6.252	-6.253	-6.254	-440
-430	-6.217	-6.220	-6.223	-6.225	-6.227	-6.230	-6.232	-6.234	-6.236	-6.238	-6.240	-430
-420	-6.187	-6.191	-6.194	-6.197	-6.200	-6.203	-6.206	-6.209	-6.212	-6.215	-6.217	-420
-410	-6.150	-6.154	-6.158	-6.162	-6.166	-6.170	-6.173	-6.177	-6.181	-6.184	-6.187	-410
-400	-6.105	-6.110	-6.115	-6.119	-6.124	-6.128	-6.133	-6.137	-6.142	-6.146	-6.150	-400
-390	-6.053	-6.059	-6.064	-6.069	-6.075	-6.080	-6.085	-6.090	-6.095	-6.100	-6.105	-390
-380	-5.995	-6.001	-6.007	-6.013	-6.019	-6.025	-6.030	-6.036	-6.042	-6.048	-6.053	-380
-370	-5.930	-5.937	-5.943	-5.950	-5.957	-5.963	-5.969	-5.976	-5.982	-5.988	-5.995	-370
-360	-5.860	-5.867	-5.874	-5.881	-5.889	-5.896	-5.903	-5.910	-5.916	-5.923	-5.930	-360
-350	-5.785	-5.792	-5.800	-5.808	-5.815	-5.823	-5.830	-5.838	-5.845	-5.853	-5.860	-350
-340	-5.705	-5.713	-5.721	-5.729	-5.737	-5.745	-5.753	-5.761	-5.769	-5.777	-5.785	-340
-330	-5.620	-5.629	-5.638	-5.646	-5.655	-5.663	-5.672	-5.680	-5.688	-5.697	-5.705	-330
-320	-5.532	-5.541	-5.550	-5.559	-5.568	-5.576	-5.585	-5.594	-5.603	-5.612	-5.620	-320
-310	-5.439	-5.448	-5.457	-5.467	-5.476	-5.486	-5.495	-5.504	-5.513	-5.522	-5.532	-310
-300	-5.341	-5.351	-5.361	-5.371	-5.381	-5.390	-5.400	-5.410	-5.419	-5.429	-5.439	-300
-290	-5.240	-5.250	-5.261	-5.271	-5.281	-5.291	-5.301	-5.311	-5.321	-5.331	-5.341	-290
-280	-5.135	-5.145	-5.156	-5.167	-5.177	-5.188	-5.198	-5.209	-5.219	-5.230	-5.240	-280
-270	-5.025	-5.036	-5.047	-5.058	-5.069	-5.080	-5.091	-5.102	-5.113	-5.124	-5.135	-270
-260	-4.912	-4.923	-4.935	-4.946	-4.958	-4.969	-4.980	-4.992	-5.003	-5.014	-5.025	-260
-250	-4.794	-4.806	-4.818	-4.830	-4.842	-4.853	-4.865	-4.877	-4.889	-4.900	-4.912	-250
-240	-4.673	-4.685	-4.698	-4.710	-4.722	-4.734	-4.746	-4.758	-4.770	-4.782	-4.794	-240
-230	-4.548	-4.560	-4.573	-4.586	-4.598	-4.611	-4.623	-4.636	-4.648	-4.661	-4.673	-230
-220	-4.419	-4.432	-4.445	-4.458	-4.471	-4.484	-4.497	-4.509	-4.522	-4.535	-4.548	-220
-210	-4.286	-4.299	-4.313	-4.326	-4.339	-4.353	-4.366	-4.379	-4.392	-4.406	-4.419	-210
-200	-4.149	-4.163	-4.177	-4.191	-4.204	-4.218	-4.232	-4.245	-4.259	-4.272	-4.286	-200
DEG F	0	1	2	3	4	5	6	7	8	9	10	DEG F

* CONVERTED FROM DEGREES C(IPTS 1968).

OMEGA ENGINEERING, INC.
An OMEGA Group Company
One Omega Drive, Box 4047, Stamford, CT 06907
(203) 359-1660 Telex 996404 Cable OMEGA

TABLE XI — Continued

TYPE T

New Reference Tables
Supersedes N.B.S.
Circular #561

Copper Vs. Copper-Nickel

(Copper-Constantan)

Temperature in Degrees F
Reference Junction at 32°F

THERMOELECTRIC VOLTAGE IN ABSOLUTE MILLIVOLTS

DEG F	0	1	2	3	4	5	6	7	8	9	10	DEC F
-190	-4.009	-4.023	-4.037	-4.051	-4.065	-4.079	-4.093	-4.107	-4.121	-4.135	-4.149	-190
-180	-3.864	-3.879	-3.894	-3.908	-3.923	-3.937	-3.951	-3.966	-3.980	-3.994	-4.009	-180
-170	-3.717	-3.732	-3.746	-3.761	-3.776	-3.791	-3.806	-3.820	-3.835	-3.850	-3.864	-170
-160	-3.565	-3.580	-3.596	-3.611	-3.626	-3.641	-3.656	-3.671	-3.687	-3.702	-3.717	-160
-150	-3.410	-3.425	-3.441	-3.457	-3.472	-3.488	-3.503	-3.519	-3.534	-3.550	-3.565	-150
-140	-3.251	-3.267	-3.283	-3.299	-3.315	-3.331	-3.347	-3.362	-3.378	-3.394	-3.410	-140
-130	-3.089	-3.105	-3.121	-3.138	-3.154	-3.170	-3.186	-3.203	-3.219	-3.235	-3.251	-130
-120	-2.923	-2.939	-2.956	-2.973	-2.989	-3.006	-3.023	-3.039	-3.056	-3.072	-3.089	-120
-110	-2.753	-2.771	-2.788	-2.805	-2.822	-2.838	-2.855	-2.872	-2.889	-2.906	-2.923	-110
-100	-2.581	-2.598	-2.616	-2.633	-2.650	-2.667	-2.685	-2.702	-2.719	-2.736	-2.753	-100
-90	-2.405	-2.422	-2.440	-2.458	-2.475	-2.493	-2.511	-2.528	-2.546	-2.563	-2.581	-90
-80	-2.225	-2.243	-2.261	-2.279	-2.297	-2.315	-2.333	-2.351	-2.369	-2.387	-2.405	-80
-70	-2.042	-2.061	-2.079	-2.098	-2.116	-2.134	-2.152	-2.171	-2.189	-2.207	-2.225	-70
-60	-1.856	-1.875	-1.894	-1.912	-1.931	-1.950	-1.968	-1.987	-2.005	-2.024	-2.042	-60
-50	-1.667	-1.686	-1.705	-1.724	-1.743	-1.762	-1.781	-1.800	-1.819	-1.838	-1.856	-50
-40	-1.475	-1.494	-1.513	-1.533	-1.552	-1.571	-1.591	-1.610	-1.629	-1.648	-1.667	-40
-30	-1.279	-1.299	-1.319	-1.338	-1.358	-1.377	-1.397	-1.416	-1.436	-1.455	-1.475	-30
-20	-1.081	-1.101	-1.121	-1.141	-1.160	-1.180	-1.200	-1.220	-1.240	-1.260	-1.279	-20
-10	-0.879	-0.899	-0.920	-0.940	-0.960	-0.980	-1.000	-1.021	-1.041	-1.061	-1.081	-10
0	-0.674	-0.695	-0.716	-0.736	-0.757	-0.777	-0.798	-0.818	-0.838	-0.859	-0.879	0

DEG F	0	1	2	3	4	5	6	7	8	9	10	DEG F
0	-0.674	-0.654	-0.633	-0.613	-0.592	-0.571	-0.550	-0.529	-0.509	-0.488	-0.467	0
10	-0.467	-0.446	-0.425	-0.404	-0.383	-0.362	-0.341	-0.320	-0.299	-0.277	-0.256	10
20	-0.256	-0.235	-0.214	-0.193	-0.171	-0.150	-0.129	-0.107	-0.086	-0.064	-0.043	20
30	-0.043	-0.022	0.000	0.022	0.043	0.065	0.086	0.108	0.130	0.151	0.173	30
40	0.173	0.195	0.216	0.238	0.260	0.282	0.303	0.325	0.347	0.369	0.391	40
50	0.391	0.413	0.435	0.457	0.479	0.501	0.523	0.545	0.567	0.589	0.611	50
60	0.611	0.634	0.656	0.678	0.700	0.722	0.745	0.767	0.789	0.812	0.834	60
70	0.834	0.857	0.879	0.902	0.924	0.947	0.969	0.992	1.014	1.037	1.060	70
80	1.060	1.082	1.105	1.128	1.151	1.173	1.196	1.219	1.242	1.265	1.288	80
90	1.288	1.311	1.334	1.357	1.380	1.403	1.426	1.449	1.472	1.495	1.518	90
100	1.518	1.542	1.565	1.588	1.611	1.635	1.658	1.681	1.705	1.728	1.752	100
110	1.752	1.775	1.799	1.822	1.846	1.869	1.893	1.917	1.940	1.964	1.988	110
120	1.988	2.011	2.035	2.059	2.083	2.107	2.131	2.154	2.178	2.202	2.226	120
130	2.226	2.250	2.274	2.298	2.322	2.347	2.371	2.395	2.419	2.443	2.467	130
140	2.467	2.492	2.516	2.540	2.565	2.589	2.613	2.638	2.662	2.687	2.711	140
150	2.711	2.736	2.760	2.785	2.809	2.834	2.859	2.883	2.908	2.933	2.958	150
160	2.958	2.982	3.007	3.032	3.057	3.082	3.107	3.131	3.156	3.181	3.206	160
170	3.206	3.231	3.256	3.281	3.307	3.332	3.357	3.382	3.407	3.432	3.458	170
180	3.458	3.483	3.508	3.533	3.559	3.584	3.609	3.635	3.660	3.686	3.711	180
190	3.711	3.737	3.762	3.788	3.813	3.839	3.864	3.890	3.916	3.941	3.967	190
200	3.967	3.993	4.019	4.044	4.070	4.096	4.122	4.148	4.174	4.199	4.225	200
210	4.225	4.251	4.277	4.303	4.329	4.355	4.381	4.408	4.434	4.460	4.486	210
220	4.486	4.512	4.538	4.565	4.591	4.617	4.643	4.670	4.696	4.722	4.749	220
230	4.749	4.775	4.801	4.828	4.854	4.881	4.907	4.934	4.960	4.987	5.014	230
240	5.014	5.040	5.067	5.093	5.120	5.147	5.174	5.200	5.227	5.254	5.281	240
250	5.281	5.307	5.334	5.361	5.388	5.415	5.442	5.469	5.496	5.523	5.550	250
260	5.550	5.577	5.604	5.631	5.658	5.685	5.712	5.739	5.767	5.794	5.821	260
270	5.821	5.848	5.875	5.903	5.930	5.957	5.985	6.012	6.039	6.067	6.094	270
280	6.094	6.122	6.149	6.177	6.204	6.232	6.259	6.287	6.314	6.342	6.369	280
290	6.369	6.397	6.425	6.452	6.480	6.508	6.536	6.563	6.591	6.619	6.647	290
300	6.647	6.675	6.702	6.730	6.758	6.786	6.814	6.842	6.870	6.898	6.926	300
310	6.926	6.954	6.982	7.010	7.038	7.066	7.094	7.122	7.151	7.179	7.207	310
320	7.207	7.235	7.263	7.292	7.320	7.348	7.377	7.405	7.433	7.462	7.490	320
330	7.490	7.518	7.547	7.575	7.604	7.632	7.661	7.689	7.718	7.746	7.775	330
340	7.775	7.804	7.832	7.861	7.889	7.918	7.947	7.975	8.004	8.033	8.062	340
350	8.062	8.090	8.119	8.148	8.177	8.206	8.235	8.264	8.292	8.321	8.350	350
360	8.350	8.379	8.408	8.437	8.466	8.495	8.524	8.553	8.583	8.612	8.641	360
370	8.641	8.670	8.699	8.728	8.757	8.787	8.816	8.845	8.874	8.904	8.933	370
380	8.933	8.962	8.992	9.021	9.050	9.080	9.109	9.139	9.168	9.198	9.227	380
390	9.227	9.257	9.286	9.316	9.345	9.375	9.404	9.434	9.464	9.493	9.523	390
400	9.523	9.553	9.582	9.612	9.642	9.671	9.701	9.731	9.761	9.791	9.820	400
410	9.820	9.850	9.880	9.910	9.940	9.970	10.000	10.030	10.060	10.090	10.120	410
420	10.120	10.150	10.180	10.210	10.240	10.270	10.300	10.330	10.360	10.390	10.420	420
430	10.420	10.451	10.481	10.511	10.541	10.572	10.602	10.632	10.662	10.693	10.723	430
440	10.723	10.753	10.784	10.814	10.845	10.875	10.905	10.936	10.966	10.997	11.027	440
450	11.027	11.058	11.088	11.119	11.149	11.180	11.211	11.241	11.272	11.302	11.333	450
460	11.333	11.364	11.394	11.425	11.456	11.487	11.517	11.548	11.579	11.610	11.640	460
470	11.640	11.671	11.702	11.733	11.764	11.795	11.826	11.856	11.887	11.918	11.949	470
480	11.949	11.980	12.011	12.042	12.073	12.104	12.135	12.166	12.198	12.229	12.260	480
490	12.260	12.291	12.322	12.353	12.384	12.416	12.447	12.478	12.509	12.540	12.572	490
500	12.572	12.603	12.634	12.666	12.697	12.728	12.760	12.791	12.822	12.854	12.885	500
510	12.885	12.917	12.948	12.979	13.011	13.042	13.074	13.105	13.137	13.168	13.200	510
520	13.200	13.232	13.263	13.295	13.326	13.358	13.390	13.421	13.453	13.485	13.516	520
530	13.516	13.548	13.580	13.611	13.643	13.675	13.707	13.739	13.770	13.802	13.834	530
540	13.834	13.866	13.898	13.930	13.961	13.993	14.025	14.057	14.089	14.121	14.153	540
550	14.153	14.185	14.217	14.249	14.281	14.313	14.345	14.377	14.409	14.441	14.474	550
560	14.474	14.506	14.538	14.570	14.602	14.634	14.666	14.699	14.731	14.763	14.795	560
570	14.795	14.828	14.860	14.892	14.924	14.957	14.989	15.021	15.054	15.086	15.118	570
580	15.118	15.151	15.183	15.216	15.248	15.280	15.313	15.345	15.378	15.410	15.443	580
590	15.443	15.475	15.508	15.540	15.573	15.605	15.638	15.671	15.703	15.736	15.769	590
600	15.769	15.801	15.834	15.866	15.899	15.932	15.965	15.997	16.030	16.063	16.096	600
610	16.096	16.128	16.161	16.194	16.227	16.259	16.292	16.325	16.358	16.391	16.424	610
620	16.424	16.457	16.490	16.523	16.555	16.588	16.621	16.654	16.687	16.720	16.753	620
630	16.753	16.786	16.819	16.852	16.886	16.919	16.952	16.985	17.018	17.051	17.084	630
640	17.084	17.117	17.150	17.184	17.217	17.250	17.283	17.316	17.350	17.383	17.416	640
650	17.416	17.450	17.483	17.516	17.549	17.583	17.616	17.649	17.683	17.716	17.750	650
660	17.750	17.783	17.816	17.850	17.883	17.917	17.950	17.984	18.017	18.051	18.084	660
670	18.084	18.118	18.151	18.185	18.218	18.252	18.285	18.319	18.353	18.386	18.420	670
680	18.420	18.454	18.487	18.521	18.555	18.588	18.622	18.656	18.689	18.723	18.757	680
690	18.757	18.791	18.824	18.858	18.892	18.926	18.960	18.993	19.027	19.061	19.095	690
700	19.095	19.129	19.163	19.197	19.230	19.264	19.298	19.332	19.366	19.400	19.434	700
710	19.434	19.468	19.502	19.536	19.570	19.604	19.638	19.672	19.706	19.740	19.774	710
720	19.774	19.808	19.843	19.877	19.911	19.945	19.979	20.013	20.047	20.081	20.116	720
730	20.116	20.150	20.184	20.218	20.252	20.287	20.321	20.355	20.389	20.423	20.458	730
740	20.458	20.492	20.526	20.560	20.595	20.629	20.663	20.698	20.732	20.766	20.801	740
750	20.801	20.835	20.869									750
DEG F	0	1	2	3	4	5	6	7	8	9	10	DEG F

* CONVERTED FROM DEGREES C(IPTS 1968).

OMEGA ENGINEERING, INC.

An OMEGA Group Company

One Omega Drive, Box 4047, Stamford, CT 06907
(203) 359-1660   Telex 996404   Cable OMEGA

TABLE XII

TYPE S

New Reference Tables
Supersedes N.B.S.
Circular #561

Platinum Vs. Platinum-10% Rhodium

Temperature in Degrees F
Reference Junction at 32°F

THERMOELECTRIC VOLTAGE IN ABSOLUTE MILLIVOLTS

DEG F	0	1	2	3	4	5	6	7	8	9	10	DEG F
0	-0.092	-0.089	-0.086	-0.084	-0.081	-0.078	-0.075	-0.073	-0.070	-0.067	-0.064	0
10	-0.064	-0.061	-0.058	-0.056	-0.053	-0.050	-0.047	-0.044	-0.041	-0.038	-0.035	10
20	-0.035	-0.033	-0.030	-0.027	-0.024	-0.021	-0.018	-0.015	-0.012	-0.009	-0.006	20
30	-0.006	-0.003	0.000	0.003	0.006	0.009	0.012	0.015	0.018	0.021	0.024	30
40	0.024	0.027	0.030	0.033	0.037	0.040	0.043	0.046	0.049	0.052	0.055	40
50	0.055	0.058	0.062	0.065	0.068	0.071	0.074	0.077	0.081	0.084	0.087	50
60	0.087	0.090	0.093	0.097	0.100	0.103	0.106	0.110	0.113	0.116	0.119	60
70	0.119	0.123	0.126	0.129	0.133	0.136	0.139	0.142	0.146	0.149	0.152	70
80	0.152	0.156	0.159	0.163	0.166	0.169	0.173	0.176	0.179	0.183	0.186	80
90	0.186	0.190	0.193	0.197	0.200	0.203	0.207	0.210	0.214	0.217	0.221	90
100	0.221	0.224	0.228	0.231	0.235	0.238	0.242	0.245	0.249	0.252	0.256	100
110	0.256	0.259	0.263	0.266	0.270	0.274	0.277	0.281	0.284	0.288	0.291	110
120	0.291	0.295	0.299	0.302	0.306	0.309	0.313	0.317	0.320	0.324	0.328	120
130	0.328	0.331	0.335	0.339	0.342	0.346	0.350	0.353	0.357	0.361	0.365	130
140	0.365	0.368	0.372	0.376	0.379	0.383	0.387	0.391	0.394	0.398	0.402	140
150	0.402	0.406	0.409	0.413	0.417	0.421	0.425	0.428	0.432	0.436	0.440	150
160	0.440	0.444	0.448	0.451	0.455	0.459	0.463	0.467	0.471	0.474	0.478	160
170	0.478	0.482	0.486	0.490	0.494	0.498	0.502	0.506	0.510	0.513	0.517	170
180	0.517	0.521	0.525	0.529	0.533	0.537	0.541	0.545	0.549	0.553	0.557	180
190	0.557	0.561	0.565	0.569	0.573	0.577	0.581	0.585	0.589	0.593	0.597	190
200	0.597	0.601	0.605	0.609	0.613	0.617	0.621	0.625	0.629	0.633	0.637	200
210	0.637	0.641	0.645	0.649	0.653	0.658	0.662	0.666	0.670	0.674	0.678	210
220	0.678	0.682	0.686	0.690	0.695	0.699	0.703	0.707	0.711	0.715	0.719	220
230	0.719	0.724	0.728	0.732	0.736	0.740	0.744	0.749	0.753	0.757	0.761	230
240	0.761	0.765	0.770	0.774	0.778	0.782	0.786	0.791	0.795	0.799	0.803	240
250	0.803	0.808	0.812	0.816	0.820	0.824	0.829	0.833	0.837	0.842	0.846	250
260	0.846	0.850	0.854	0.859	0.863	0.867	0.872	0.876	0.880	0.884	0.889	260
270	0.889	0.893	0.897	0.902	0.906	0.910	0.915	0.919	0.923	0.928	0.932	270
280	0.932	0.936	0.941	0.945	0.950	0.954	0.958	0.963	0.967	0.971	0.976	280
290	0.976	0.980	0.985	0.989	0.993	0.998	1.002	1.007	1.011	1.015	1.020	290
300	1.020	1.024	1.029	1.033	1.038	1.042	1.046	1.051	1.055	1.060	1.064	300
310	1.064	1.069	1.073	1.078	1.082	1.087	1.091	1.095	1.100	1.104	1.109	310
320	1.109	1.113	1.118	1.122	1.127	1.131	1.136	1.140	1.145	1.149	1.154	320
330	1.154	1.158	1.163	1.168	1.172	1.177	1.181	1.186	1.190	1.195	1.199	330
340	1.199	1.204	1.208	1.213	1.218	1.222	1.227	1.231	1.236	1.240	1.245	340
350	1.245	1.250	1.254	1.259	1.263	1.268	1.273	1.277	1.282	1.286	1.291	350
360	1.291	1.296	1.300	1.305	1.309	1.314	1.319	1.323	1.328	1.333	1.337	360
370	1.337	1.342	1.347	1.351	1.356	1.360	1.365	1.370	1.374	1.379	1.384	370
380	1.384	1.388	1.393	1.398	1.402	1.407	1.412	1.417	1.421	1.426	1.431	380
390	1.431	1.435	1.440	1.445	1.449	1.454	1.459	1.464	1.468	1.473	1.478	390
400	1.478	1.482	1.487	1.492	1.497	1.501	1.506	1.511	1.516	1.520	1.525	400
410	1.525	1.530	1.535	1.539	1.544	1.549	1.554	1.558	1.563	1.568	1.573	410
420	1.573	1.577	1.582	1.587	1.592	1.597	1.601	1.606	1.611	1.616	1.620	420
430	1.620	1.625	1.630	1.635	1.640	1.644	1.649	1.654	1.659	1.664	1.669	430
440	1.669	1.673	1.678	1.683	1.688	1.693	1.698	1.702	1.707	1.712	1.717	440
450	1.717	1.722	1.727	1.731	1.736	1.741	1.746	1.751	1.756	1.761	1.765	450
460	1.765	1.770	1.775	1.780	1.785	1.790	1.795	1.799	1.804	1.809	1.814	460
470	1.814	1.819	1.824	1.829	1.834	1.839	1.843	1.848	1.853	1.858	1.863	470
480	1.863	1.868	1.873	1.878	1.883	1.888	1.893	1.898	1.902	1.907	1.912	480
490	1.912	1.917	1.922	1.927	1.932	1.937	1.942	1.947	1.952	1.957	1.962	490
500	1.962	1.967	1.972	1.977	1.981	1.986	1.991	1.996	2.001	2.006	2.011	500
510	2.011	2.016	2.021	2.026	2.031	2.036	2.041	2.046	2.051	2.056	2.061	510
520	2.061	2.066	2.071	2.076	2.081	2.086	2.091	2.096	2.101	2.106	2.111	520
530	2.111	2.116	2.121	2.126	2.131	2.136	2.141	2.146	2.151	2.156	2.161	530
540	2.161	2.166	2.171	2.176	2.181	2.186	2.191	2.196	2.201	2.206	2.211	540
550	2.211	2.216	2.221	2.227	2.232	2.237	2.242	2.247	2.252	2.257	2.262	550
560	2.262	2.267	2.272	2.277	2.282	2.287	2.292	2.297	2.302	2.307	2.313	560
570	2.313	2.318	2.323	2.328	2.333	2.338	2.343	2.348	2.353	2.358	2.363	570
580	2.363	2.368	2.374	2.379	2.384	2.389	2.394	2.399	2.404	2.409	2.414	580
590	2.414	2.419	2.425	2.430	2.435	2.440	2.445	2.450	2.455	2.460	2.465	590
600	2.465	2.471	2.476	2.481	2.486	2.491	2.496	2.501	2.506	2.512	2.517	600
610	2.517	2.522	2.527	2.532	2.537	2.542	2.548	2.553	2.558	2.563	2.568	610
620	2.568	2.573	2.578	2.584	2.589	2.594	2.599	2.604	2.609	2.615	2.620	620
630	2.620	2.625	2.630	2.635	2.640	2.646	2.651	2.656	2.661	2.666	2.672	630
640	2.672	2.677	2.682	2.687	2.692	2.697	2.703	2.708	2.713	2.718	2.723	640
650	2.723	2.729	2.734	2.739	2.744	2.749	2.755	2.760	2.765	2.770	2.775	650
660	2.775	2.781	2.786	2.791	2.796	2.801	2.807	2.812	2.817	2.822	2.828	660
670	2.828	2.833	2.838	2.843	2.848	2.854	2.859	2.864	2.869	2.875	2.880	670
680	2.880	2.885	2.890	2.895	2.901	2.906	2.911	2.916	2.922	2.927	2.932	680
690	2.932	2.937	2.943	2.948	2.953	2.958	2.964	2.969	2.974	2.979	2.985	690
700	2.985	2.990	2.995	3.000	3.006	3.011	3.016	3.022	3.027	3.032	3.037	700
710	3.037	3.043	3.048	3.053	3.058	3.064	3.069	3.074	3.080	3.085	3.090	710
720	3.090	3.095	3.101	3.106	3.111	3.117	3.122	3.127	3.132	3.138	3.143	720
730	3.143	3.148	3.154	3.159	3.164	3.169	3.175	3.180	3.185	3.191	3.196	730
740	3.196	3.201	3.207	3.212	3.217	3.223	3.228	3.233	3.238	3.244	3.249	740
750	3.249	3.254	3.260	3.265	3.270	3.276	3.281	3.286	3.292	3.297	3.302	750
760	3.302	3.308	3.313	3.318	3.324	3.329	3.334	3.340	3.345	3.350	3.356	760
770	3.356	3.361	3.366	3.372	3.377	3.382	3.388	3.393	3.398	3.404	3.409	770
780	3.409	3.414	3.420	3.425	3.430	3.436	3.441	3.447	3.452	3.457	3.463	780
790	3.463	3.468	3.473	3.479	3.484	3.489	3.495	3.500	3.506	3.511	3.516	790
800	3.516	3.522	3.527	3.532	3.538	3.543	3.549	3.554	3.559	3.565	3.570	800
810	3.570	3.575	3.581	3.586	3.592	3.597	3.602	3.608	3.613	3.619	3.624	810
820	3.624	3.629	3.635	3.640	3.645	3.651	3.656	3.662	3.667	3.672	3.678	820
830	3.678	3.683	3.689	3.694	3.699	3.705	3.710	3.716	3.721	3.726	3.732	830
840	3.732	3.737	3.743	3.748	3.754	3.759	3.764	3.770	3.775	3.781	3.786	840
850	3.786	3.791	3.797	3.802	3.808	3.813	3.819	3.824	3.829	3.835	3.840	850
860	3.840	3.846	3.851	3.857	3.862	3.867	3.873	3.878	3.884	3.889	3.895	860
870	3.895	3.900	3.906	3.911	3.916	3.922	3.927	3.933	3.938	3.944	3.949	870
880	3.949	3.955	3.960	3.965	3.971	3.976	3.982	3.987	3.993	3.998	4.004	880
890	4.004	4.009	4.015	4.020	4.025	4.031	4.036	4.042	4.047	4.053	4.058	890
900	4.058	4.064	4.069	4.075	4.080	4.086	4.091	4.096	4.102	4.107	4.113	900
910	4.113	4.118	4.124	4.129	4.135	4.140	4.146	4.151	4.157	4.162	4.168	910
920	4.168	4.173	4.179	4.184	4.190	4.195	4.201	4.206	4.212	4.217	4.223	920
930	4.223	4.228	4.234	4.239	4.245	4.250	4.256	4.261	4.267	4.272	4.278	930
940	4.278	4.283	4.289	4.294	4.300	4.305	4.311	4.316	4.322	4.327	4.333	940
950	4.333	4.338	4.344	4.349	4.355	4.360	4.366	4.371	4.377	4.382	4.388	950
960	4.388	4.393	4.399	4.404	4.410	4.415	4.421	4.426	4.432	4.438	4.443	960
970	4.443	4.449	4.454	4.460	4.465	4.471	4.476	4.482	4.487	4.493	4.498	970
980	4.498	4.504	4.509	4.515	4.521	4.526	4.532	4.537	4.543	4.548	4.554	980
990	4.554	4.559	4.565	4.570	4.576	4.582	4.587	4.593	4.598	4.604	4.609	990
1,000	4.609	4.615	4.620	4.626	4.632	4.637	4.643	4.648	4.654	4.659	4.665	1,000
1,010	4.665	4.670	4.676	4.682	4.687	4.693	4.698	4.704	4.709	4.715	4.721	1,010
1,020	4.721	4.726	4.732	4.737	4.743	4.748	4.754	4.760	4.765	4.771	4.776	1,020
1,030	4.776	4.782	4.788	4.793	4.799	4.804	4.810	4.815	4.821	4.827	4.832	1,030
1,040	4.832	4.838	4.843	4.849	4.855	4.860	4.866	4.871	4.877	4.883	4.888	1,040
1,050	4.888	4.894	4.899	4.905	4.911	4.916	4.922	4.927	4.933	4.939	4.944	1,050
1,060	4.944	4.950	4.956	4.961	4.967	4.972	4.978	4.984	4.989	4.995	5.000	1,060
1,070	5.000	5.006	5.012	5.017	5.023	5.029	5.034	5.040	5.045	5.051	5.057	1,070
1,080	5.057	5.062	5.068	5.074	5.079	5.085	5.090	5.096	5.102	5.107	5.113	1,080
1,090	5.113	5.119	5.124	5.130	5.136	5.141	5.147	5.153	5.158	5.164	5.169	1,090
DEG F	0	1	2	3	4	5	6	7	8	9	10	DEG F

* CONVERTED FROM DEGREES C(IPTS 1968).

OMEGA
ENGINEERING, INC.
An OMEGA Group Company
One Omega Drive, Box 4047, Stamford, CT 06907
(203) 359-1660 Telex 996404 Cable OMEGA

TABLE XII — Continued

TYPE S

New Reference Tables
Supersedes N.B.S.
Circular #561

Platinum Vs. Platinum-10% Rhodium

Temperature in Degrees F
Reference Junction at 32°F

THERMOELECTRIC VOLTAGE IN ABSOLUTE MILLIVOLTS

DEG F	0	1	2	3	4	5	6	7	8	9	10	DEG F
1,100	5.169	5.175	5.181	5.186	5.192	5.198	5.203	5.209	5.215	5.220	5.226	1,100
1,110	5.226	5.232	5.237	5.243	5.249	5.254	5.260	5.266	5.271	5.277	5.283	1,110
1,120	5.283	5.288	5.294	5.300	5.305	5.311	5.317	5.322	5.328	5.334	5.339	1,120
1,130	5.339	5.345	5.351	5.356	5.362	5.368	5.373	5.379	5.385	5.391	5.396	1,130
1,140	5.396	5.402	5.408	5.413	5.419	5.425	5.430	5.436	5.442	5.447	5.453	1,140
1,150	5.453	5.459	5.465	5.470	5.476	5.482	5.487	5.493	5.499	5.504	5.510	1,150
1,160	5.510	5.516	5.522	5.527	5.533	5.539	5.544	5.550	5.556	5.562	5.567	1,160
1,170	5.567	5.573	5.579	5.585	5.590	5.596	5.602	5.608	5.613	5.619	5.625	1,170
1,180	5.625	5.631	5.636	5.642	5.648	5.653	5.659	5.665	5.671	5.676	5.682	1,180
1,190	5.682	5.688	5.694	5.700	5.705	5.711	5.717	5.723	5.728	5.734	5.740	1,190
1,200	5.740	5.746	5.751	5.757	5.763	5.769	5.774	5.780	5.786	5.792	5.797	1,200
1,210	5.797	5.803	5.809	5.815	5.821	5.826	5.832	5.838	5.844	5.849	5.855	1,210
1,220	5.855	5.861	5.867	5.873	5.878	5.884	5.890	5.896	5.902	5.907	5.913	1,220
1,230	5.913	5.919	5.925	5.931	5.936	5.942	5.948	5.954	5.960	5.965	5.971	1,230
1,240	5.971	5.977	5.983	5.989	5.994	6.000	6.006	6.012	6.018	6.023	6.029	1,240
1,250	6.029	6.035	6.041	6.047	6.052	6.058	6.064	6.070	6.076	6.082	6.087	1,250
1,260	6.087	6.093	6.099	6.105	6.111	6.117	6.122	6.128	6.134	6.140	6.146	1,260
1,270	6.146	6.152	6.157	6.163	6.169	6.175	6.181	6.187	6.192	6.198	6.204	1,270
1,280	6.204	6.210	6.216	6.222	6.227	6.233	6.239	6.245	6.251	6.257	6.263	1,280
1,290	6.263	6.268	6.274	6.280	6.286	6.292	6.298	6.304	6.309	6.315	6.321	1,290
1,300	6.321	6.327	6.333	6.339	6.345	6.350	6.356	6.362	6.368	6.374	6.380	1,300
1,310	6.380	6.386	6.392	6.397	6.403	6.409	6.415	6.421	6.427	6.433	6.439	1,310
1,320	6.439	6.445	6.450	6.456	6.462	6.468	6.474	6.480	6.486	6.492	6.498	1,320
1,330	6.498	6.503	6.509	6.515	6.521	6.527	6.533	6.539	6.545	6.551	6.557	1,330
1,340	6.557	6.562	6.568	6.574	6.580	6.586	6.592	6.598	6.604	6.610	6.616	1,340
1,350	6.616	6.622	6.627	6.633	6.639	6.645	6.651	6.657	6.663	6.669	6.675	1,350
1,360	6.675	6.681	6.687	6.693	6.699	6.704	6.710	6.716	6.722	6.728	6.734	1,360
1,370	6.734	6.740	6.746	6.752	6.758	6.764	6.770	6.776	6.782	6.788	6.794	1,370
1,380	6.794	6.800	6.805	6.811	6.817	6.823	6.829	6.835	6.841	6.847	6.853	1,380
1,390	6.853	6.859	6.865	6.871	6.877	6.883	6.889	6.895	6.901	6.907	6.913	1,390
1,400	6.913	6.919	6.925	6.931	6.937	6.943	6.948	6.954	6.960	6.966	6.972	1,400
1,410	6.972	6.978	6.984	6.990	6.996	7.002	7.008	7.014	7.020	7.026	7.032	1,410
1,420	7.032	7.038	7.044	7.050	7.056	7.062	7.068	7.074	7.080	7.086	7.092	1,420
1,430	7.092	7.098	7.104	7.110	7.116	7.122	7.128	7.134	7.140	7.146	7.152	1,430
1,440	7.152	7.158	7.164	7.170	7.176	7.182	7.188	7.194	7.200	7.206	7.212	1,440
1,450	7.212	7.218	7.224	7.230	7.236	7.242	7.248	7.254	7.260	7.266	7.272	1,450
1,460	7.272	7.278	7.285	7.291	7.297	7.303	7.309	7.315	7.321	7.327	7.333	1,460
1,470	7.333	7.339	7.345	7.351	7.357	7.363	7.369	7.375	7.381	7.387	7.393	1,470
1,480	7.393	7.399	7.405	7.411	7.417	7.423	7.429	7.436	7.442	7.448	7.454	1,480
1,490	7.454	7.460	7.466	7.472	7.478	7.484	7.490	7.496	7.502	7.508	7.514	1,490
1,500	7.514	7.520	7.526	7.533	7.539	7.545	7.551	7.557	7.563	7.569	7.575	1,500
1,510	7.575	7.581	7.587	7.593	7.599	7.605	7.612	7.618	7.624	7.630	7.636	1,510
1,520	7.636	7.642	7.648	7.654	7.660	7.666	7.672	7.679	7.685	7.691	7.697	1,520
1,530	7.697	7.703	7.709	7.715	7.721	7.727	7.733	7.740	7.746	7.752	7.758	1,530
1,540	7.758	7.764	7.770	7.776	7.782	7.788	7.795	7.801	7.807	7.813	7.819	1,540
1,550	7.819	7.825	7.831	7.837	7.843	7.850	7.856	7.862	7.868	7.874	7.880	1,550
1,560	7.880	7.886	7.892	7.899	7.905	7.911	7.917	7.923	7.929	7.935	7.942	1,560
1,570	7.942	7.948	7.954	7.960	7.966	7.972	7.978	7.985	7.991	7.997	8.003	1,570
1,580	8.003	8.009	8.015	8.021	8.028	8.034	8.040	8.046	8.052	8.058	8.065	1,580
1,590	8.065	8.071	8.077	8.083	8.089	8.095	8.101	8.108	8.114	8.120	8.126	1,590
1,600	8.126	8.132	8.138	8.145	8.151	8.157	8.163	8.169	8.176	8.182	8.188	1,600
1,610	8.188	8.194	8.200	8.206	8.213	8.219	8.225	8.231	8.237	8.244	8.250	1,610
1,620	8.250	8.256	8.262	8.268	8.275	8.281	8.287	8.293	8.299	8.305	8.312	1,620
1,630	8.312	8.318	8.324	8.330	8.336	8.343	8.349	8.355	8.361	8.368	8.374	1,630
1,640	8.374	8.380	8.386	8.392	8.399	8.405	8.411	8.417	8.423	8.430	8.436	1,640
1,650	8.436	8.442	8.448	8.455	8.461	8.467	8.473	8.479	8.486	8.492	8.498	1,650
1,660	8.498	8.504	8.511	8.517	8.523	8.529	8.536	8.542	8.548	8.554	8.560	1,660
1,670	8.560	8.567	8.573	8.579	8.585	8.592	8.598	8.604	8.610	8.617	8.623	1,670
1,680	8.623	8.629	8.635	8.642	8.648	8.654	8.660	8.667	8.673	8.679	8.685	1,680
1,690	8.685	8.692	8.698	8.704	8.711	8.717	8.723	8.729	8.736	8.742	8.748	1,690
1,700	8.748	8.754	8.761	8.767	8.773	8.780	8.786	8.792	8.798	8.805	8.811	1,700
1,710	8.811	8.817	8.823	8.830	8.836	8.842	8.849	8.855	8.861	8.867	8.874	1,710
1,720	8.874	8.880	8.886	8.893	8.899	8.905	8.912	8.918	8.924	8.930	8.937	1,720
1,730	8.937	8.943	8.949	8.956	8.962	8.968	8.975	8.981	8.987	8.993	9.000	1,730
1,740	9.000	9.006	9.012	9.019	9.025	9.031	9.038	9.044	9.050	9.057	9.063	1,740
1,750	9.063	9.069	9.076	9.082	9.088	9.095	9.101	9.107	9.114	9.120	9.126	1,750
1,760	9.126	9.133	9.139	9.145	9.152	9.158	9.164	9.171	9.177	9.183	9.190	1,760
1,770	9.190	9.196	9.202	9.209	9.215	9.221	9.228	9.234	9.240	9.247	9.253	1,770
1,780	9.253	9.259	9.266	9.272	9.278	9.285	9.291	9.298	9.304	9.310	9.317	1,780
1,790	9.317	9.323	9.329	9.336	9.342	9.348	9.355	9.361	9.368	9.374	9.380	1,790
1,800	9.380	9.387	9.393	9.399	9.406	9.412	9.419	9.425	9.431	9.438	9.444	1,800
1,810	9.444	9.450	9.457	9.463	9.470	9.476	9.482	9.489	9.495	9.502	9.508	1,810
1,820	9.508	9.514	9.521	9.527	9.533	9.540	9.546	9.553	9.559	9.565	9.572	1,820
1,830	9.572	9.578	9.585	9.591	9.598	9.604	9.610	9.617	9.623	9.630	9.636	1,830
1,840	9.636	9.642	9.649	9.655	9.662	9.668	9.674	9.681	9.687	9.694	9.700	1,840
1,850	9.700	9.707	9.713	9.719	9.726	9.732	9.739	9.745	9.752	9.758	9.764	1,850
1,860	9.764	9.771	9.777	9.784	9.790	9.797	9.803	9.809	9.816	9.822	9.829	1,860
1,870	9.829	9.835	9.842	9.848	9.855	9.861	9.867	9.874	9.880	9.887	9.893	1,870
1,880	9.893	9.900	9.906	9.913	9.919	9.926	9.932	9.938	9.945	9.951	9.958	1,880
1,890	9.958	9.964	9.971	9.977	9.984	9.990	9.997	10.003	10.010	10.016	10.023	1,890
1,900	10.023	10.029	10.036	10.042	10.048	10.055	10.061	10.068	10.074	10.081	10.087	1,900
1,910	10.087	10.094	10.100	10.107	10.113	10.120	10.126	10.133	10.139	10.146	10.152	1,910
1,920	10.152	10.159	10.165	10.172	10.178	10.185	10.191	10.198	10.204	10.211	10.217	1,920
1,930	10.217	10.224	10.230	10.237	10.243	10.250	10.256	10.263	10.269	10.276	10.282	1,930
1,940	10.282	10.289	10.295	10.302	10.308	10.315	10.321	10.328	10.334	10.341	10.348	1,940
1,950	10.348	10.354	10.361	10.367	10.374	10.380	10.387	10.393	10.400	10.406	10.413	1,950
1,960	10.413	10.419	10.426	10.432	10.439	10.445	10.452	10.459	10.465	10.472	10.478	1,960
1,970	10.478	10.485	10.491	10.498	10.504	10.511	10.517	10.524	10.531	10.537	10.544	1,970
1,980	10.544	10.550	10.557	10.563	10.570	10.576	10.583	10.589	10.596	10.603	10.609	1,980
1,990	10.609	10.616	10.622	10.629	10.635	10.642	10.648	10.655	10.662	10.668	10.675	1,990
2,000	10.675	10.681	10.688	10.694	10.701	10.708	10.714	10.721	10.727	10.734	10.740	2,000
2,010	10.740	10.747	10.754	10.760	10.767	10.773	10.780	10.786	10.793	10.800	10.806	2,010
2,020	10.806	10.813	10.819	10.826	10.832	10.839	10.846	10.852	10.859	10.865	10.872	2,020
2,030	10.872	10.879	10.885	10.892	10.898	10.905	10.912	10.918	10.925	10.931	10.938	2,030
2,040	10.938	10.944	10.951	10.958	10.964	10.971	10.977	10.984	10.991	10.997	11.004	2,040
2,050	11.004	11.010	11.017	11.024	11.030	11.037	11.043	11.050	11.057	11.063	11.070	2,050
2,060	11.070	11.076	11.083	11.090	11.096	11.103	11.110	11.116	11.123	11.129	11.136	2,060
2,070	11.136	11.143	11.149	11.156	11.162	11.169	11.176	11.182	11.189	11.196	11.202	2,070
2,080	11.202	11.209	11.215	11.222	11.229	11.235	11.242	11.248	11.255	11.262	11.268	2,080
2,090	11.268	11.275	11.282	11.288	11.295	11.301	11.308	11.315	11.321	11.328	11.335	2,090
2,100	11.335	11.341	11.348	11.355	11.361	11.368	11.374	11.381	11.388	11.394	11.401	2,100
2,110	11.401	11.408	11.414	11.421	11.428	11.434	11.441	11.447	11.454	11.461	11.467	2,110
2,120	11.467	11.474	11.481	11.487	11.494	11.501	11.507	11.514	11.521	11.527	11.534	2,120
2,130	11.534	11.541	11.547	11.554	11.560	11.567	11.574	11.580	11.587	11.594	11.600	2,130
2,140	11.600	11.607	11.614	11.620	11.627	11.634	11.640	11.647	11.654	11.660	11.667	2,140
2,150	11.667	11.674	11.680	11.687	11.694	11.700	11.707	11.714	11.720	11.727	11.734	2,150
2,160	11.734	11.740	11.747	11.754	11.760	11.767	11.774	11.780	11.787	11.794	11.800	2,160
2,170	11.800	11.807	11.814	11.820	11.827	11.834	11.840	11.847	11.854	11.860	11.867	2,170
2,180	11.867	11.874	11.880	11.887	11.894	11.900	11.907	11.914	11.920	11.927	11.934	2,180
2,190	11.934	11.940	11.947	11.954	11.960	11.967	11.974	11.980	11.987	11.994	12.001	2,190
DEG F	0	1	2	3	4	5	6	7	8	9	10	DEG F

* CONVERTED FROM DEGREES C(IPTS 1968).

OMEGA
ENGINEERING, INC.
An OMEGA Group Company
One Omega Drive, Box 4047, Stamford, CT 06907
(203) 359-1660 Telex 996404 Cable OMEGA

TABLE XII — Continued

TYPE S

New Reference Tables
Supersedes N.B.S.
Circular #561

Platinum Vs. Platinum-10% Rhodium

Temperature in Degrees F
Reference Junction at 32°F

THERMOELECTRIC VOLTAGE IN ABSOLUTE MILLIVOLTS

DEG F	0	1	2	3	4	5	6	7	8	9	10	DEG F
2,200	12.001	12.007	12.014	12.021	12.027	12.034	12.041	12.047	12.054	12.061	12.067	2,200
2,210	12.067	12.074	12.081	12.087	12.094	12.101	12.107	12.114	12.121	12.128	12.134	2,210
2,220	12.134	12.141	12.148	12.154	12.161	12.168	12.174	12.181	12.188	12.194	12.201	2,220
2,230	12.201	12.208	12.215	12.221	12.228	12.235	12.241	12.248	12.255	12.261	12.268	2,230
2,240	12.268	12.275	12.282	12.288	12.295	12.302	12.308	12.315	12.322	12.328	12.335	2,240
2,250	12.335	12.342	12.349	12.355	12.362	12.369	12.375	12.382	12.389	12.395	12.402	2,250
2,260	12.402	12.409	12.416	12.422	12.429	12.436	12.442	12.449	12.456	12.463	12.469	2,260
2,270	12.469	12.476	12.483	12.489	12.496	12.503	12.510	12.516	12.523	12.530	12.536	2,270
2,280	12.536	12.543	12.550	12.557	12.563	12.570	12.577	12.583	12.590	12.597	12.604	2,280
2,290	12.604	12.610	12.617	12.624	12.630	12.637	12.644	12.651	12.657	12.664	12.671	2,290
2,300	12.671	12.677	12.684	12.691	12.698	12.704	12.711	12.718	12.724	12.731	12.738	2,300
2,310	12.738	12.745	12.751	12.758	12.765	12.771	12.778	12.785	12.792	12.798	12.805	2,310
2,320	12.805	12.812	12.819	12.825	12.832	12.839	12.845	12.852	12.859	12.866	12.872	2,320
2,330	12.872	12.879	12.886	12.893	12.899	12.906	12.913	12.919	12.926	12.933	12.940	2,330
2,340	12.940	12.946	12.953	12.960	12.967	12.973	12.980	12.987	12.993	13.000	13.007	2,340
2,350	13.007	13.014	13.020	13.027	13.034	13.041	13.047	13.054	13.061	13.067	13.074	2,350
2,360	13.074	13.081	13.088	13.094	13.101	13.108	13.115	13.121	13.128	13.135	13.142	2,360
2,370	13.142	13.148	13.155	13.162	13.168	13.175	13.182	13.189	13.195	13.202	13.209	2,370
2,380	13.209	13.216	13.222	13.229	13.236	13.243	13.249	13.256	13.263	13.269	13.276	2,380
2,390	13.276	13.283	13.290	13.296	13.303	13.310	13.317	13.323	13.330	13.337	13.344	2,390
2,400	13.344	13.350	13.357	13.364	13.371	13.377	13.384	13.391	13.397	13.404	13.411	2,400
2,410	13.411	13.418	13.424	13.431	13.438	13.445	13.451	13.458	13.465	13.472	13.478	2,410
2,420	13.478	13.485	13.492	13.499	13.505	13.512	13.519	13.526	13.532	13.539	13.546	2,420
2,430	13.546	13.552	13.559	13.566	13.573	13.579	13.586	13.593	13.600	13.606	13.613	2,430
2,440	13.613	13.620	13.627	13.633	13.640	13.647	13.654	13.660	13.667	13.674	13.681	2,440
2,450	13.681	13.687	13.694	13.701	13.708	13.714	13.721	13.728	13.734	13.741	13.748	2,450
2,460	13.748	13.755	13.761	13.768	13.775	13.782	13.788	13.795	13.802	13.809	13.815	2,460
2,470	13.815	13.822	13.829	13.836	13.842	13.849	13.856	13.863	13.869	13.876	13.883	2,470
2,480	13.883	13.890	13.896	13.903	13.910	13.916	13.923	13.930	13.937	13.943	13.950	2,480
2,490	13.950	13.957	13.964	13.970	13.977	13.984	13.991	13.997	14.004	14.011	14.018	2,490
2,500	14.018	14.024	14.031	14.038	14.045	14.051	14.058	14.065	14.072	14.078	14.085	2,500
2,510	14.085	14.092	14.098	14.105	14.112	14.119	14.125	14.132	14.139	14.146	14.152	2,510
2,520	14.152	14.159	14.166	14.173	14.179	14.186	14.193	14.200	14.206	14.213	14.220	2,520
2,530	14.220	14.226	14.233	14.240	14.247	14.253	14.260	14.267	14.274	14.280	14.287	2,530
2,540	14.287	14.294	14.301	14.307	14.314	14.321	14.328	14.334	14.341	14.348	14.354	2,540
2,550	14.354	14.361	14.368	14.375	14.381	14.388	14.395	14.402	14.408	14.415	14.422	2,550
2,560	14.422	14.429	14.435	14.442	14.449	14.455	14.462	14.469	14.476	14.482	14.489	2,560
2,570	14.489	14.496	14.503	14.509	14.516	14.523	14.530	14.536	14.543	14.550	14.556	2,570
2,580	14.556	14.563	14.570	14.577	14.583	14.590	14.597	14.604	14.610	14.617	14.624	2,580
2,590	14.624	14.631	14.637	14.644	14.651	14.657	14.664	14.671	14.678	14.684	14.691	2,590
2,600	14.691	14.698	14.705	14.711	14.718	14.725	14.731	14.738	14.745	14.752	14.758	2,600
2,610	14.758	14.765	14.772	14.778	14.785	14.792	14.799	14.805	14.812	14.819	14.826	2,610
2,620	14.826	14.832	14.839	14.846	14.852	14.859	14.866	14.873	14.879	14.886	14.893	2,620
2,630	14.893	14.899	14.906	14.913	14.920	14.926	14.933	14.940	14.946	14.953	14.960	2,630
2,640	14.960	14.967	14.973	14.980	14.987	14.994	15.000	15.007	15.014	15.020	15.027	2,640
2,650	15.027	15.034	15.041	15.047	15.054	15.061	15.067	15.074	15.081	15.088	15.094	2,650
2,660	15.094	15.101	15.108	15.114	15.121	15.128	15.134	15.141	15.148	15.155	15.161	2,660
2,670	15.161	15.168	15.175	15.181	15.188	15.195	15.202	15.208	15.215	15.222	15.228	2,670
2,680	15.228	15.235	15.242	15.248	15.255	15.262	15.269	15.275	15.282	15.289	15.295	2,680
2,690	15.295	15.302	15.309	15.315	15.322	15.329	15.336	15.342	15.349	15.356	15.362	2,690
2,700	15.362	15.369	15.376	15.382	15.389	15.396	15.403	15.409	15.416	15.423	15.429	2,700
2,710	15.429	15.436	15.443	15.449	15.456	15.463	15.469	15.476	15.483	15.490	15.496	2,710
2,720	15.496	15.503	15.510	15.516	15.523	15.530	15.536	15.543	15.550	15.556	15.563	2,720
2,730	15.563	15.570	15.576	15.583	15.590	15.597	15.603	15.610	15.617	15.623	15.630	2,730
2,740	15.630	15.637	15.643	15.650	15.657	15.663	15.670	15.677	15.683	15.690	15.697	2,740
2,750	15.697	15.703	15.710	15.717	15.723	15.730	15.737	15.743	15.750	15.757	15.763	2,750
2,760	15.763	15.770	15.777	15.783	15.790	15.797	15.804	15.810	15.817	15.824	15.830	2,760
2,770	15.830	15.837	15.844	15.850	15.857	15.864	15.870	15.877	15.883	15.890	15.897	2,770
2,780	15.897	15.903	15.910	15.917	15.923	15.930	15.937	15.943	15.950	15.957	15.963	2,780
2,790	15.963	15.970	15.977	15.983	15.990	15.997	16.003	16.010	16.017	16.023	16.030	2,790
2,800	16.030	16.037	16.043	16.050	16.057	16.063	16.070	16.077	16.083	16.090	16.096	2,800
2,810	16.096	16.103	16.110	16.116	16.123	16.130	16.136	16.143	16.150	16.156	16.163	2,810
2,820	16.163	16.170	16.176	16.183	16.189	16.196	16.203	16.209	16.216	16.223	16.229	2,820
2,830	16.229	16.236	16.243	16.249	16.256	16.262	16.269	16.276	16.282	16.289	16.296	2,830
2,840	16.296	16.302	16.309	16.315	16.322	16.329	16.335	16.342	16.349	16.355	16.362	2,840
2,850	16.362	16.368	16.375	16.382	16.388	16.395	16.402	16.408	16.415	16.421	16.428	2,850
2,860	16.428	16.435	16.441	16.448	16.454	16.461	16.468	16.474	16.481	16.488	16.494	2,860
2,870	16.494	16.501	16.507	16.514	16.521	16.527	16.534	16.540	16.547	16.554	16.560	2,870
2,880	16.560	16.567	16.573	16.580	16.587	16.593	16.600	16.606	16.613	16.620	16.626	2,880
2,890	16.626	16.633	16.639	16.646	16.653	16.659	16.666	16.672	16.679	16.686	16.692	2,890
2,900	16.692	16.699	16.705	16.712	16.719	16.725	16.732	16.738	16.745	16.751	16.758	2,900
2,910	16.758	16.765	16.771	16.778	16.784	16.791	16.797	16.804	16.811	16.817	16.824	2,910
2,920	16.824	16.830	16.837	16.844	16.850	16.857	16.863	16.870	16.876	16.883	16.890	2,920
2,930	16.890	16.896	16.903	16.909	16.916	16.922	16.929	16.935	16.942	16.949	16.955	2,930
2,940	16.955	16.962	16.968	16.975	16.981	16.988	16.995	17.001	17.008	17.014	17.021	2,940
2,950	17.021	17.027	17.034	17.040	17.047	17.053	17.060	17.067	17.073	17.080	17.086	2,950
2,960	17.086	17.093	17.099	17.106	17.112	17.119	17.125	17.132	17.139	17.145	17.152	2,960
2,970	17.152	17.158	17.165	17.171	17.178	17.184	17.191	17.197	17.204	17.210	17.217	2,970
2,980	17.217	17.223	17.230	17.237	17.243	17.250	17.256	17.263	17.269	17.276	17.282	2,980
2,990	17.282	17.289	17.295	17.302	17.308	17.315	17.321	17.328	17.334	17.341	17.347	2,990
3,000	17.347	17.354	17.360	17.367	17.373	17.380	17.386	17.393	17.399	17.406	17.412	3,000
3,010	17.412	17.419	17.425	17.432	17.438	17.445	17.451	17.458	17.464	17.471	17.477	3,010
3,020	17.477	17.484	17.490	17.497	17.503	17.510	17.516	17.523	17.529	17.536	17.542	3,020
3,030	17.542	17.549	17.555	17.562	17.568	17.575	17.581	17.588	17.594	17.601	17.607	3,030
3,040	17.607	17.614	17.620	17.627	17.633	17.639	17.646	17.652	17.659	17.665	17.672	3,040
3,050	17.672	17.678	17.685	17.691	17.698	17.704	17.711	17.717	17.723	17.730	17.736	3,050
3,060	17.736	17.743	17.749	17.756	17.762	17.769	17.775	17.781	17.788	17.794	17.801	3,060
3,070	17.801	17.807	17.814	17.820	17.826	17.833	17.839	17.846	17.852	17.859	17.865	3,070
3,080	17.865	17.871	17.878	17.884	17.891	17.897	17.903	17.910	17.916	17.923	17.929	3,080
3,090	17.929	17.935	17.942	17.948	17.954	17.961	17.967	17.974	17.980	17.986	17.993	3,090
3,100	17.993	17.999	18.005	18.012	18.018	18.024	18.031	18.037	18.043	18.050	18.056	3,100
3,110	18.056	18.063	18.069	18.075	18.081	18.088	18.094	18.100	18.107	18.113	18.119	3,110
3,120	18.119	18.126	18.132	18.138	18.145	18.151	18.157	18.163	18.170	18.176	18.182	3,120
3,130	18.182	18.189	18.195	18.201	18.207	18.214	18.220	18.226	18.232	18.239	18.245	3,130
3,140	18.245	18.251	18.257	18.264	18.270	18.276	18.282	18.289	18.295	18.301	18.307	3,140
3,150	18.307	18.313	18.320	18.326	18.332	18.338	18.344	18.351	18.357	18.363	18.369	3,150
3,160	18.369	18.375	18.381	18.388	18.394	18.400	18.406	18.412	18.418	18.424	18.431	3,160
3,170	18.431	18.437	18.443	18.449	18.455	18.461	18.467	18.473	18.479	18.486	18.492	3,170
3,180	18.492	18.498	18.504	18.510	18.516	18.522	18.528	18.534	18.540	18.546	18.552	3,180
3,190	18.552	18.558	18.564	18.570	18.576	18.582	18.588	18.594	18.600	18.606	18.612	3,190
3,200	18.612	18.618	18.624	18.630	18.636	18.642	18.648	18.654	18.660	18.666	18.672	3,200
3,210	18.672	18.678	18.684	18.690	18.696							3,210
DEG F	0	1	2	3	4	5	6	7	8	9	10	DEG F

* CONVERTED FROM DEGREES C(IPTS 1968).

OMEGA ENGINEERING, INC.
An OMEGA Group Company
One Omega Drive, Box 4047, Stamford, CT 06907
(203) 359-1660 Telex 996404 Cable OMEGA

TABLE XIII

TYPE R

New Reference Tables
Supersedes N.B.S.
Circular #561

Platinum Vs. Platinum-13% Rhodium

Temperature in Degrees F
Reference Junction at 32°F

THERMOELECTRIC VOLTAGE IN ABSOLUTE MILLIVOLTS

DEG F	0	1	2	3	4	5	6	7	8	9	10	DEG F
0	-0.089	-0.087	-0.084	-0.082	-0.079	-0.076	-0.073	-0.071	-0.068	-0.065	-0.063	0
10	-0.063	-0.060	-0.057	-0.054	-0.051	-0.049	-0.046	-0.043	-0.040	-0.037	-0.035	10
20	-0.035	-0.032	-0.029	-0.026	-0.023	-0.020	-0.017	-0.015	-0.012	-0.009	-0.006	20
30	-0.006	-0.003	0.000	0.003	0.006	0.009	0.012	0.015	0.018	0.021	0.024	30
40	0.024	0.027	0.030	0.033	0.036	0.039	0.042	0.045	0.048	0.051	0.054	40
50	0.054	0.057	0.060	0.064	0.067	0.070	0.073	0.076	0.079	0.082	0.086	50
60	0.086	0.089	0.092	0.095	0.098	0.101	0.105	0.108	0.111	0.114	0.118	60
70	0.118	0.121	0.124	0.127	0.131	0.134	0.137	0.141	0.144	0.147	0.150	70
80	0.150	0.154	0.157	0.161	0.164	0.167	0.171	0.174	0.177	0.181	0.184	80
90	0.184	0.188	0.191	0.194	0.198	0.201	0.205	0.208	0.212	0.215	0.218	90
100	0.218	0.222	0.225	0.229	0.232	0.236	0.239	0.243	0.246	0.250	0.253	100
110	0.253	0.257	0.261	0.264	0.268	0.271	0.275	0.278	0.282	0.286	0.289	110
120	0.289	0.293	0.296	0.300	0.304	0.307	0.311	0.315	0.318	0.322	0.326	120
130	0.326	0.329	0.333	0.337	0.340	0.344	0.348	0.351	0.355	0.359	0.363	130
140	0.363	0.366	0.370	0.374	0.378	0.381	0.385	0.389	0.393	0.397	0.400	140
150	0.400	0.404	0.408	0.412	0.416	0.419	0.423	0.427	0.431	0.435	0.439	150
160	0.439	0.443	0.446	0.450	0.454	0.458	0.462	0.466	0.470	0.474	0.478	160
170	0.478	0.482	0.485	0.489	0.493	0.497	0.501	0.505	0.509	0.513	0.517	170
180	0.517	0.521	0.525	0.529	0.533	0.537	0.541	0.545	0.549	0.553	0.557	180
190	0.557	0.561	0.565	0.569	0.573	0.577	0.581	0.586	0.590	0.594	0.598	190
200	0.598	0.602	0.606	0.610	0.614	0.618	0.622	0.627	0.631	0.635	0.639	200
210	0.639	0.643	0.647	0.651	0.656	0.660	0.664	0.668	0.672	0.676	0.681	210
220	0.681	0.685	0.689	0.693	0.697	0.702	0.706	0.710	0.714	0.719	0.723	220
230	0.723	0.727	0.731	0.736	0.740	0.744	0.748	0.753	0.757	0.761	0.766	230
240	0.766	0.770	0.774	0.778	0.783	0.787	0.791	0.796	0.800	0.804	0.809	240
250	0.809	0.813	0.817	0.822	0.826	0.830	0.835	0.839	0.844	0.848	0.852	250
260	0.852	0.857	0.861	0.866	0.870	0.874	0.879	0.883	0.888	0.892	0.897	260
270	0.897	0.901	0.905	0.910	0.914	0.919	0.923	0.928	0.932	0.937	0.941	270
280	0.941	0.946	0.950	0.955	0.959	0.964	0.968	0.973	0.977	0.982	0.986	280
290	0.986	0.991	0.995	1.000	1.004	1.009	1.013	1.018	1.022	1.027	1.032	290
300	1.032	1.036	1.041	1.045	1.050	1.054	1.059	1.064	1.068	1.073	1.077	300
310	1.077	1.082	1.087	1.091	1.096	1.101	1.105	1.110	1.114	1.119	1.124	310
320	1.124	1.128	1.133	1.138	1.142	1.147	1.152	1.156	1.161	1.166	1.170	320
330	1.170	1.175	1.180	1.184	1.189	1.194	1.199	1.203	1.208	1.213	1.217	330
340	1.217	1.222	1.227	1.232	1.236	1.241	1.246	1.251	1.255	1.260	1.265	340
350	1.265	1.270	1.274	1.279	1.284	1.289	1.294	1.298	1.303	1.308	1.313	350
360	1.313	1.318	1.322	1.327	1.332	1.337	1.342	1.346	1.351	1.356	1.361	360
370	1.361	1.366	1.371	1.375	1.380	1.385	1.390	1.395	1.400	1.405	1.409	370
380	1.409	1.414	1.419	1.424	1.429	1.434	1.439	1.444	1.449	1.453	1.458	380
390	1.458	1.463	1.468	1.473	1.478	1.483	1.488	1.493	1.498	1.503	1.508	390
400	1.508	1.512	1.517	1.522	1.527	1.532	1.537	1.542	1.547	1.552	1.557	400
410	1.557	1.562	1.567	1.572	1.577	1.582	1.587	1.592	1.597	1.602	1.607	410
420	1.607	1.612	1.617	1.622	1.627	1.632	1.637	1.642	1.647	1.652	1.657	420
430	1.657	1.662	1.667	1.672	1.677	1.682	1.687	1.692	1.698	1.703	1.708	430
440	1.708	1.713	1.718	1.723	1.728	1.733	1.738	1.743	1.748	1.753	1.758	440
450	1.758	1.764	1.769	1.774	1.779	1.784	1.789	1.794	1.799	1.804	1.810	450
460	1.810	1.815	1.820	1.825	1.830	1.835	1.840	1.845	1.851	1.856	1.861	460
470	1.861	1.866	1.871	1.876	1.882	1.887	1.892	1.897	1.902	1.907	1.913	470
480	1.913	1.918	1.923	1.928	1.933	1.938	1.944	1.949	1.954	1.959	1.964	480
490	1.964	1.970	1.975	1.980	1.985	1.991	1.996	2.001	2.006	2.011	2.017	490
500	2.017	2.022	2.027	2.032	2.038	2.043	2.048	2.053	2.059	2.064	2.069	500
510	2.069	2.074	2.080	2.085	2.090	2.095	2.101	2.106	2.111	2.117	2.122	510
520	2.122	2.127	2.132	2.138	2.143	2.148	2.154	2.159	2.164	2.170	2.175	520
530	2.175	2.180	2.186	2.191	2.196	2.201	2.207	2.212	2.217	2.223	2.228	530
540	2.228	2.233	2.239	2.244	2.249	2.255	2.260	2.266	2.271	2.276	2.282	540
550	2.282	2.287	2.292	2.298	2.303	2.308	2.314	2.319	2.325	2.330	2.335	550
560	2.335	2.341	2.346	2.351	2.357	2.362	2.368	2.373	2.378	2.384	2.389	560
570	2.389	2.395	2.400	2.405	2.411	2.416	2.422	2.427	2.433	2.438	2.443	570
580	2.443	2.449	2.454	2.460	2.465	2.471	2.476	2.481	2.487	2.492	2.498	580
590	2.498	2.503	2.509	2.514	2.520	2.525	2.531	2.536	2.541	2.547	2.552	590
600	2.552	2.558	2.563	2.569	2.574	2.580	2.585	2.591	2.596	2.602	2.607	600
610	2.607	2.613	2.618	2.624	2.629	2.635	2.640	2.646	2.651	2.657	2.662	610
620	2.662	2.668	2.673	2.679	2.684	2.690	2.695	2.701	2.706	2.712	2.718	620
630	2.718	2.723	2.729	2.734	2.740	2.745	2.751	2.756	2.762	2.767	2.773	630
640	2.773	2.779	2.784	2.790	2.795	2.801	2.806	2.812	2.818	2.823	2.829	640
650	2.829	2.834	2.840	2.845	2.851	2.857	2.862	2.868	2.873	2.879	2.885	650
660	2.885	2.890	2.896	2.901	2.907	2.913	2.918	2.924	2.929	2.935	2.941	660
670	2.941	2.946	2.952	2.957	2.963	2.969	2.974	2.980	2.986	2.991	2.997	670
680	2.997	3.002	3.008	3.014	3.019	3.025	3.031	3.036	3.042	3.048	3.053	680
690	3.053	3.059	3.065	3.070	3.076	3.082	3.087	3.093	3.099	3.104	3.110	690
700	3.110	3.116	3.121	3.127	3.133	3.138	3.144	3.150	3.155	3.161	3.167	700
710	3.167	3.172	3.178	3.184	3.189	3.195	3.201	3.207	3.212	3.218	3.224	710
720	3.224	3.229	3.235	3.241	3.247	3.252	3.258	3.264	3.269	3.275	3.281	720
730	3.281	3.287	3.292	3.298	3.304	3.309	3.315	3.321	3.327	3.332	3.338	730
740	3.338	3.344	3.350	3.355	3.361	3.367	3.373	3.378	3.384	3.390	3.396	740
750	3.396	3.401	3.407	3.413	3.419	3.424	3.430	3.436	3.442	3.448	3.453	750
760	3.453	3.459	3.465	3.471	3.476	3.482	3.488	3.494	3.500	3.505	3.511	760
770	3.511	3.517	3.523	3.529	3.534	3.540	3.546	3.552	3.558	3.563	3.569	770
780	3.569	3.575	3.581	3.587	3.592	3.598	3.604	3.610	3.616	3.622	3.627	780
790	3.627	3.633	3.639	3.645	3.651	3.657	3.662	3.668	3.674	3.680	3.686	790
800	3.686	3.692	3.697	3.703	3.709	3.715	3.721	3.727	3.733	3.738	3.744	800
810	3.744	3.750	3.756	3.762	3.768	3.774	3.779	3.785	3.791	3.797	3.803	810
820	3.803	3.809	3.815	3.821	3.826	3.832	3.838	3.844	3.850	3.856	3.862	820
830	3.862	3.868	3.874	3.879	3.885	3.891	3.897	3.903	3.909	3.915	3.921	830
840	3.921	3.927	3.933	3.938	3.944	3.950	3.956	3.962	3.968	3.974	3.980	840
850	3.980	3.986	3.992	3.998	4.004	4.009	4.015	4.021	4.027	4.033	4.039	850
860	4.039	4.045	4.051	4.057	4.063	4.069	4.075	4.081	4.087	4.093	4.099	860
870	4.099	4.105	4.110	4.116	4.122	4.128	4.134	4.140	4.146	4.152	4.158	870
880	4.158	4.164	4.170	4.176	4.182	4.188	4.194	4.200	4.206	4.212	4.218	880
890	4.218	4.224	4.230	4.236	4.242	4.248	4.254	4.260	4.266	4.272	4.278	890
900	4.278	4.284	4.290	4.296	4.302	4.308	4.314	4.320	4.326	4.332	4.338	900
910	4.338	4.344	4.350	4.356	4.362	4.368	4.374	4.380	4.386	4.392	4.398	910
920	4.398	4.404	4.410	4.416	4.422	4.428	4.434	4.440	4.446	4.452	4.458	920
930	4.458	4.465	4.471	4.477	4.483	4.489	4.495	4.501	4.507	4.513	4.519	930
940	4.519	4.525	4.531	4.537	4.543	4.549	4.555	4.561	4.567	4.574	4.580	940
950	4.580	4.586	4.592	4.598	4.604	4.610	4.616	4.622	4.628	4.634	4.640	950
960	4.640	4.647	4.653	4.659	4.665	4.671	4.677	4.683	4.689	4.695	4.701	960
970	4.701	4.707	4.714	4.720	4.726	4.732	4.738	4.744	4.750	4.756	4.762	970
980	4.762	4.769	4.775	4.781	4.787	4.793	4.799	4.805	4.811	4.818	4.824	980
990	4.824	4.830	4.836	4.842	4.848	4.854	4.860	4.867	4.873	4.879	4.885	990
1,000	4.885	4.891	4.897	4.904	4.910	4.916	4.922	4.928	4.934	4.940	4.947	1,000
1,010	4.947	4.953	4.959	4.965	4.971	4.977	4.984	4.990	4.996	5.002	5.008	1,010
1,020	5.008	5.014	5.021	5.027	5.033	5.039	5.045	5.052	5.058	5.064	5.070	1,020
1,030	5.070	5.076	5.082	5.089	5.095	5.101	5.107	5.113	5.120	5.126	5.132	1,030
1,040	5.132	5.138	5.144	5.151	5.157	5.163	5.169	5.175	5.182	5.188	5.194	1,040
1,050	5.194	5.200	5.207	5.213	5.219	5.225	5.231	5.238	5.244	5.250	5.256	1,050
1,060	5.256	5.263	5.269	5.275	5.281	5.288	5.294	5.300	5.306	5.313	5.319	1,060
1,070	5.319	5.325	5.331	5.337	5.344	5.350	5.356	5.362	5.369	5.375	5.381	1,070
1,080	5.381	5.388	5.394	5.400	5.406	5.413	5.419	5.425	5.431	5.438	5.444	1,080
1,090	5.444	5.450	5.456	5.463	5.469	5.475	5.482	5.488	5.494	5.500	5.507	1,090
DEG F	0	1	2	3	4	5	6	7	8	9	10	DEG F

* CONVERTED FROM DEGREES C(IPTS 1968).

OMEGA ENGINEERING, INC.
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TABLE XIII — Continued

TYPE R

New Reference Tables
Supersedes N.B.S.
Circular #561

Platinum Vs. Platinum-13% Rhodium

Temperature in Degrees F
Reference Junction at 32°F

THERMOELECTRIC VOLTAGE IN ABSOLUTE MILLIVOLTS

DEG F	0	1	2	3	4	5	6	7	8	9	10	DEG F
1,100	5.507	5.513	5.519	5.526	5.532	5.538	5.544	5.551	5.557	5.563	5.570	1,100
1,110	5.570	5.576	5.582	5.589	5.595	5.601	5.607	5.614	5.620	5.626	5.633	1,110
1,120	5.633	5.639	5.645	5.652	5.658	5.664	5.671	5.677	5.683	5.690	5.696	1,120
1,130	5.696	5.702	5.709	5.715	5.721	5.728	5.734	5.740	5.747	5.753	5.759	1,130
1,140	5.759	5.766	5.772	5.778	5.785	5.791	5.797	5.804	5.810	5.816	5.823	1,140
1,150	5.823	5.829	5.835	5.842	5.848	5.855	5.861	5.867	5.874	5.880	5.886	1,150
1,160	5.886	5.893	5.899	5.905	5.912	5.918	5.925	5.931	5.937	5.944	5.950	1,160
1,170	5.950	5.957	5.963	5.969	5.976	5.982	5.988	5.995	6.001	6.008	6.014	1,170
1,180	6.014	6.021	6.027	6.033	6.040	6.046	6.053	6.059	6.065	6.072	6.078	1,180
1,190	6.078	6.085	6.091	6.098	6.104	6.110	6.117	6.123	6.130	6.136	6.143	1,190
1,200	6.143	6.149	6.155	6.162	6.168	6.175	6.181	6.188	6.194	6.201	6.207	1,200
1,210	6.207	6.213	6.220	6.226	6.233	6.239	6.246	6.252	6.259	6.265	6.272	1,210
1,220	6.272	6.278	6.285	6.291	6.297	6.304	6.310	6.317	6.323	6.330	6.336	1,220
1,230	6.336	6.343	6.349	6.356	6.362	6.369	6.375	6.382	6.388	6.395	6.401	1,230
1,240	6.401	6.408	6.414	6.421	6.427	6.434	6.440	6.447	6.453	6.460	6.466	1,240
1,250	6.466	6.473	6.479	6.486	6.492	6.499	6.505	6.512	6.518	6.525	6.532	1,250
1,260	6.532	6.538	6.545	6.551	6.558	6.564	6.571	6.577	6.584	6.590	6.597	1,260
1,270	6.597	6.603	6.610	6.616	6.623	6.630	6.636	6.643	6.649	6.656	6.662	1,270
1,280	6.662	6.669	6.675	6.682	6.689	6.695	6.702	6.708	6.715	6.721	6.728	1,280
1,290	6.728	6.735	6.741	6.748	6.754	6.761	6.767	6.774	6.781	6.787	6.794	1,290
1,300	6.794	6.800	6.807	6.814	6.820	6.827	6.833	6.840	6.847	6.853	6.860	1,300
1,310	6.860	6.866	6.873	6.880	6.886	6.893	6.899	6.906	6.913	6.919	6.926	1,310
1,320	6.926	6.932	6.939	6.946	6.952	6.959	6.966	6.972	6.979	6.985	6.992	1,320
1,330	6.992	6.999	7.005	7.012	7.019	7.025	7.032	7.039	7.045	7.052	7.059	1,330
1,340	7.059	7.065	7.072	7.078	7.085	7.092	7.098	7.105	7.112	7.118	7.125	1,340
1,350	7.125	7.132	7.138	7.145	7.152	7.158	7.165	7.172	7.178	7.185	7.192	1,350
1,360	7.192	7.198	7.205	7.212	7.218	7.225	7.232	7.239	7.245	7.252	7.259	1,360
1,370	7.259	7.265	7.272	7.279	7.285	7.292	7.299	7.305	7.312	7.319	7.326	1,370
1,380	7.326	7.332	7.339	7.346	7.352	7.359	7.366	7.373	7.379	7.386	7.393	1,380
1,390	7.393	7.399	7.406	7.413	7.420	7.426	7.433	7.440	7.447	7.453	7.460	1,390
1,400	7.460	7.467	7.474	7.480	7.487	7.494	7.500	7.507	7.514	7.521	7.527	1,400
1,410	7.527	7.534	7.541	7.548	7.554	7.561	7.568	7.575	7.582	7.588	7.595	1,410
1,420	7.595	7.602	7.609	7.615	7.622	7.629	7.636	7.642	7.649	7.656	7.663	1,420
1,430	7.663	7.670	7.676	7.683	7.690	7.697	7.703	7.710	7.717	7.724	7.731	1,430
1,440	7.731	7.737	7.744	7.751	7.758	7.765	7.771	7.778	7.785	7.792	7.799	1,440
1,450	7.799	7.805	7.812	7.819	7.826	7.833	7.840	7.846	7.853	7.860	7.867	1,450
1,460	7.867	7.874	7.880	7.887	7.894	7.901	7.908	7.915	7.921	7.928	7.935	1,460
1,470	7.935	7.942	7.949	7.956	7.963	7.969	7.976	7.983	7.990	7.997	8.004	1,470
1,480	8.004	8.010	8.017	8.024	8.031	8.038	8.045	8.052	8.058	8.065	8.072	1,480
1,490	8.072	8.079	8.086	8.093	8.100	8.107	8.113	8.120	8.127	8.134	8.141	1,490
1,500	8.141	8.148	8.155	8.162	8.168	8.175	8.182	8.189	8.196	8.203	8.210	1,500
1,510	8.210	8.217	8.224	8.231	8.237	8.244	8.251	8.258	8.265	8.272	8.279	1,510
1,520	8.279	8.286	8.293	8.300	8.306	8.313	8.320	8.327	8.334	8.341	8.348	1,520
1,530	8.348	8.355	8.362	8.369	8.376	8.383	8.390	8.397	8.403	8.410	8.417	1,530
1,540	8.417	8.424	8.431	8.438	8.445	8.452	8.459	8.466	8.473	8.480	8.487	1,540
1,550	8.487	8.494	8.501	8.508	8.515	8.522	8.529	8.535	8.542	8.549	8.556	1,550
1,560	8.556	8.563	8.570	8.577	8.584	8.591	8.598	8.605	8.612	8.619	8.626	1,560
1,570	8.626	8.633	8.640	8.647	8.654	8.661	8.668	8.675	8.682	8.689	8.696	1,570
1,580	8.696	8.703	8.710	8.717	8.724	8.731	8.738	8.745	8.752	8.759	8.766	1,580
1,590	8.766	8.773	8.780	8.787	8.794	8.801	8.808	8.815	8.822	8.829	8.836	1,590
1,600	8.836	8.843	8.850	8.857	8.864	8.871	8.878	8.885	8.892	8.899	8.907	1,600
1,610	8.907	8.914	8.921	8.928	8.935	8.942	8.949	8.956	8.963	8.970	8.977	1,610
1,620	8.977	8.984	8.991	8.998	9.005	9.012	9.019	9.026	9.033	9.040	9.048	1,620
1,630	9.048	9.055	9.062	9.069	9.076	9.083	9.090	9.097	9.104	9.111	9.118	1,630
1,640	9.118	9.125	9.132	9.140	9.147	9.154	9.161	9.168	9.175	9.182	9.189	1,640
1,650	9.189	9.196	9.203	9.210	9.218	9.225	9.232	9.239	9.246	9.253	9.260	1,650
1,660	9.260	9.267	9.274	9.282	9.289	9.296	9.303	9.310	9.317	9.324	9.331	1,660
1,670	9.331	9.338	9.346	9.353	9.360	9.367	9.374	9.381	9.388	9.395	9.403	1,670
1,680	9.403	9.410	9.417	9.424	9.431	9.438	9.445	9.453	9.460	9.467	9.474	1,680
1,690	9.474	9.481	9.488	9.495	9.503	9.510	9.517	9.524	9.531	9.538	9.546	1,690
1,700	9.546	9.553	9.560	9.567	9.574	9.581	9.589	9.596	9.603	9.610	9.617	1,700
1,710	9.617	9.624	9.632	9.639	9.646	9.653	9.660	9.668	9.675	9.682	9.689	1,710
1,720	9.689	9.696	9.704	9.711	9.718	9.725	9.732	9.740	9.747	9.754	9.761	1,720
1,730	9.761	9.768	9.776	9.783	9.790	9.797	9.804	9.812	9.819	9.826	9.833	1,730
1,740	9.833	9.840	9.848	9.855	9.862	9.869	9.877	9.884	9.891	9.898	9.906	1,740
1,750	9.906	9.913	9.920	9.927	9.934	9.942	9.949	9.956	9.963	9.971	9.978	1,750
1,760	9.978	9.985	9.992	10.000	10.007	10.014	10.021	10.029	10.036	10.043	10.050	1,760
1,770	10.050	10.058	10.065	10.072	10.079	10.087	10.094	10.101	10.109	10.116	10.123	1,770
1,780	10.123	10.130	10.138	10.145	10.152	10.159	10.167	10.174	10.181	10.189	10.196	1,780
1,790	10.196	10.203	10.210	10.218	10.225	10.232	10.240	10.247	10.254	10.262	10.269	1,790
1,800	10.269	10.276	10.283	10.291	10.298	10.305	10.313	10.320	10.327	10.335	10.342	1,800
1,810	10.342	10.349	10.357	10.364	10.371	10.379	10.386	10.393	10.400	10.408	10.415	1,810
1,820	10.415	10.422	10.430	10.437	10.444	10.452	10.459	10.466	10.474	10.481	10.488	1,820
1,830	10.488	10.496	10.503	10.511	10.518	10.525	10.533	10.540	10.547	10.555	10.562	1,830
1,840	10.562	10.569	10.577	10.584	10.591	10.599	10.606	10.613	10.621	10.628	10.636	1,840
1,850	10.636	10.643	10.650	10.658	10.665	10.672	10.680	10.687	10.695	10.702	10.709	1,850
1,860	10.709	10.717	10.724	10.731	10.739	10.746	10.754	10.761	10.768	10.776	10.783	1,860
1,870	10.783	10.791	10.798	10.805	10.813	10.820	10.828	10.835	10.842	10.850	10.857	1,870
1,880	10.857	10.865	10.872	10.879	10.887	10.894	10.902	10.909	10.917	10.924	10.931	1,880
1,890	10.931	10.939	10.946	10.954	10.961	10.968	10.976	10.983	10.991	10.998	11.006	1,890
1,900	11.006	11.013	11.021	11.028	11.035	11.043	11.050	11.058	11.065	11.073	11.080	1,900
1,910	11.080	11.088	11.095	11.102	11.110	11.117	11.125	11.132	11.140	11.147	11.155	1,910
1,920	11.155	11.162	11.170	11.177	11.184	11.192	11.199	11.207	11.214	11.222	11.229	1,920
1,930	11.229	11.237	11.244	11.252	11.259	11.267	11.274	11.282	11.289	11.297	11.304	1,930
1,940	11.304	11.312	11.319	11.327	11.334	11.342	11.349	11.357	11.364	11.372	11.379	1,940
1,950	11.379	11.387	11.394	11.402	11.409	11.417	11.424	11.432	11.439	11.447	11.454	1,950
1,960	11.454	11.462	11.469	11.477	11.484	11.492	11.499	11.507	11.514	11.522	11.529	1,960
1,970	11.529	11.537	11.544	11.552	11.559	11.567	11.574	11.582	11.590	11.597	11.605	1,970
1,980	11.605	11.612	11.620	11.627	11.635	11.642	11.650	11.657	11.665	11.672	11.680	1,980
1,990	11.680	11.688	11.695	11.703	11.710	11.718	11.725	11.733	11.740	11.748	11.756	1,990
2,000	11.756	11.763	11.771	11.778	11.786	11.793	11.801	11.808	11.816	11.824	11.831	2,000
2,010	11.831	11.839	11.846	11.854	11.861	11.869	11.877	11.884	11.892	11.899	11.907	2,010
2,020	11.907	11.914	11.922	11.930	11.937	11.945	11.952	11.960	11.968	11.975	11.983	2,020
2,030	11.983	11.990	11.998	12.005	12.013	12.021	12.028	12.036	12.043	12.051	12.059	2,030
2,040	12.059	12.066	12.074	12.081	12.089	12.097	12.104	12.112	12.119	12.127	12.135	2,040
2,050	12.135	12.142	12.150	12.157	12.165	12.173	12.180	12.188	12.196	12.203	12.211	2,050
2,060	12.211	12.218	12.226	12.234	12.241	12.249	12.257	12.264	12.272	12.279	12.287	2,060
2,070	12.287	12.295	12.302	12.310	12.318	12.325	12.333	12.340	12.348	12.356	12.363	2,070
2,080	12.363	12.371	12.379	12.386	12.394	12.402	12.409	12.417	12.424	12.432	12.440	2,080
2,090	12.440	12.447	12.455	12.463	12.470	12.478	12.486	12.493	12.501	12.509	12.516	2,090
2,100	12.516	12.524	12.532	12.539	12.547	12.555	12.562	12.570	12.577	12.585	12.593	2,100
2,110	12.593	12.600	12.608	12.616	12.623	12.631	12.639	12.646	12.654	12.662	12.669	2,110
2,120	12.669	12.677	12.685	12.693	12.700	12.708	12.716	12.723	12.731	12.739	12.746	2,120
2,130	12.746	12.754	12.762	12.769	12.777	12.785	12.792	12.800	12.808	12.815	12.823	2,130
2,140	12.823	12.831	12.838	12.846	12.854	12.862	12.869	12.877	12.885	12.892	12.900	2,140
2,150	12.900	12.908	12.915	12.923	12.931	12.938	12.946	12.954	12.962	12.969	12.977	2,150
2,160	12.977	12.985	12.992	13.000	13.008	13.016	13.023	13.031	13.039	13.046	13.054	2,160
2,170	13.054	13.062	13.069	13.077	13.085	13.093	13.100	13.108	13.116	13.123	13.131	2,170
2,180	13.131	13.139	13.147	13.154	13.162	13.170	13.178	13.185	13.193	13.201	13.208	2,180
2,190	13.208	13.216	13.224	13.232	13.239	13.247	13.255	13.263	13.270	13.278	13.286	2,190
DEG F	0	1	2	3	4	5	6	7	8	9	10	DEG F

* CONVERTED FROM DEGREES C(IPTS 1968).

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An OMEGA Group Company
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(203) 359-1660 Telex 996404 Cable OMEGA

TABLE XIII — Continued

TYPE R

New Reference Tables
Supersedes N.B.S.
Circular #561

Platinum Vs. Platinum-13% Rhodium

Temperature in Degrees F
Reference Junction at 32°F

THERMOELECTRIC VOLTAGE IN ABSOLUTE MILLIVOLTS

DEG F	0	1	2	3	4	5	6	7	8	9	10	DEG F
2,200	13.286	13.293	13.301	13.309	13.317	13.324	13.332	13.340	13.348	13.355	13.363	2,200
2,210	13.363	13.371	13.379	13.386	13.394	13.402	13.409	13.417	13.425	13.433	13.440	2,210
2,220	13.440	13.448	13.456	13.464	13.471	13.479	13.487	13.495	13.502	13.510	13.518	2,220
2,230	13.518	13.526	13.533	13.541	13.549	13.557	13.564	13.572	13.580	13.588	13.595	2,230
2,240	13.595	13.603	13.611	13.619	13.627	13.634	13.642	13.650	13.658	13.665	13.673	2,240
2,250	13.673	13.681	13.689	13.696	13.704	13.712	13.720	13.727	13.735	13.743	13.751	2,250
2,260	13.751	13.759	13.766	13.774	13.782	13.790	13.797	13.805	13.813	13.821	13.828	2,260
2,270	13.828	13.836	13.844	13.852	13.860	13.867	13.875	13.883	13.891	13.898	13.906	2,270
2,280	13.906	13.914	13.922	13.930	13.937	13.945	13.953	13.961	13.968	13.976	13.984	2,280
2,290	13.984	13.992	14.000	14.007	14.015	14.023	14.031	14.039	14.046	14.054	14.062	2,290
2,300	14.062	14.070	14.078	14.085	14.093	14.101	14.109	14.116	14.124	14.132	14.140	2,300
2,310	14.140	14.148	14.155	14.163	14.171	14.179	14.187	14.194	14.202	14.210	14.218	2,310
2,320	14.218	14.226	14.233	14.241	14.249	14.257	14.265	14.272	14.280	14.288	14.296	2,320
2,330	14.296	14.304	14.311	14.319	14.327	14.335	14.343	14.350	14.358	14.366	14.374	2,330
2,340	14.374	14.382	14.389	14.397	14.405	14.413	14.421	14.429	14.436	14.444	14.452	2,340
2,350	14.452	14.460	14.468	14.475	14.483	14.491	14.499	14.507	14.514	14.522	14.530	2,350
2,360	14.530	14.538	14.546	14.554	14.561	14.569	14.577	14.585	14.593	14.600	14.608	2,360
2,370	14.608	14.616	14.624	14.632	14.640	14.647	14.655	14.663	14.671	14.679	14.686	2,370
2,380	14.686	14.694	14.702	14.710	14.718	14.726	14.733	14.741	14.749	14.757	14.765	2,380
2,390	14.765	14.772	14.780	14.788	14.796	14.804	14.812	14.819	14.827	14.835	14.843	2,390
2,400	14.843	14.851	14.859	14.866	14.874	14.882	14.890	14.898	14.906	14.913	14.921	2,400
2,410	14.921	14.929	14.937	14.945	14.953	14.960	14.968	14.976	14.984	14.992	15.000	2,410
2,420	15.000	15.007	15.015	15.023	15.031	15.039	15.047	15.054	15.062	15.070	15.078	2,420
2,430	15.078	15.086	15.094	15.101	15.109	15.117	15.125	15.133	15.141	15.148	15.156	2,430
2,440	15.156	15.164	15.172	15.180	15.188	15.195	15.203	15.211	15.219	15.227	15.235	2,440
2,450	15.235	15.242	15.250	15.258	15.266	15.274	15.282	15.289	15.297	15.305	15.313	2,450
2,460	15.313	15.321	15.329	15.337	15.344	15.352	15.360	15.368	15.376	15.384	15.391	2,460
2,470	15.391	15.399	15.407	15.415	15.423	15.431	15.438	15.446	15.454	15.462	15.470	2,470
2,480	15.470	15.478	15.486	15.493	15.501	15.509	15.517	15.525	15.533	15.540	15.548	2,480
2,490	15.548	15.556	15.564	15.572	15.580	15.587	15.595	15.603	15.611	15.619	15.627	2,490
2,500	15.627	15.635	15.642	15.650	15.658	15.666	15.674	15.682	15.689	15.697	15.705	2,500
2,510	15.705	15.713	15.721	15.729	15.737	15.744	15.752	15.760	15.768	15.776	15.784	2,510
2,520	15.784	15.791	15.799	15.807	15.815	15.823	15.831	15.839	15.846	15.854	15.862	2,520
2,530	15.862	15.870	15.878	15.886	15.893	15.901	15.909	15.917	15.925	15.933	15.941	2,530
2,540	15.941	15.948	15.956	15.964	15.972	15.980	15.988	15.995	16.003	16.011	16.019	2,540
2,550	16.019	16.027	16.035	16.043	16.050	16.058	16.066	16.074	16.082	16.090	16.097	2,550
2,560	16.097	16.105	16.113	16.121	16.129	16.137	16.145	16.152	16.160	16.168	16.176	2,560
2,570	16.176	16.184	16.192	16.199	16.207	16.215	16.223	16.231	16.239	16.247	16.254	2,570
2,580	16.254	16.262	16.270	16.278	16.286	16.294	16.301	16.309	16.317	16.325	16.333	2,580
2,590	16.333	16.341	16.349	16.356	16.364	16.372	16.380	16.388	16.396	16.403	16.411	2,590
2,600	16.411	16.419	16.427	16.435	16.443	16.450	16.458	16.466	16.474	16.482	16.490	2,600
2,610	16.490	16.498	16.505	16.513	16.521	16.529	16.537	16.545	16.552	16.560	16.568	2,610
2,620	16.568	16.576	16.584	16.592	16.599	16.607	16.615	16.623	16.631	16.639	16.646	2,620
2,630	16.646	16.654	16.662	16.670	16.678	16.686	16.694	16.701	16.709	16.717	16.725	2,630
2,640	16.725	16.733	16.741	16.748	16.756	16.764	16.772	16.780	16.788	16.795	16.803	2,640
2,650	16.803	16.811	16.819	16.827	16.835	16.842	16.850	16.858	16.866	16.874	16.882	2,650
2,660	16.882	16.889	16.897	16.905	16.913	16.921	16.929	16.936	16.944	16.952	16.960	2,660
2,670	16.960	16.968	16.976	16.983	16.991	16.999	17.007	17.015	17.022	17.030	17.038	2,670
2,680	17.038	17.046	17.054	17.062	17.069	17.077	17.085	17.093	17.101	17.109	17.116	2,680
2,690	17.116	17.124	17.132	17.140	17.148	17.156	17.163	17.171	17.179	17.187	17.195	2,690
2,700	17.195	17.202	17.210	17.218	17.226	17.234	17.242	17.249	17.257	17.265	17.273	2,700
2,710	17.273	17.281	17.288	17.296	17.304	17.312	17.320	17.328	17.335	17.343	17.351	2,710
2,720	17.351	17.359	17.367	17.374	17.382	17.390	17.398	17.406	17.413	17.421	17.429	2,720
2,730	17.429	17.437	17.445	17.453	17.460	17.468	17.476	17.484	17.492	17.499	17.507	2,730
2,740	17.507	17.515	17.523	17.531	17.538	17.546	17.554	17.562	17.570	17.577	17.585	2,740
2,750	17.585	17.593	17.601	17.609	17.616	17.624	17.632	17.640	17.648	17.655	17.663	2,750
2,760	17.663	17.671	17.679	17.687	17.694	17.702	17.710	17.718	17.726	17.733	17.741	2,760
2,770	17.741	17.749	17.757	17.765	17.772	17.780	17.788	17.796	17.804	17.811	17.819	2,770
2,780	17.819	17.827	17.835	17.842	17.850	17.858	17.866	17.874	17.881	17.889	17.897	2,780
2,790	17.897	17.905	17.913	17.920	17.928	17.936	17.944	17.951	17.959	17.967	17.975	2,790
2,800	17.975	17.983	17.990	17.998	18.006	18.014	18.021	18.029	18.037	18.045	18.053	2,800
2,810	18.053	18.060	18.068	18.076	18.084	18.091	18.099	18.107	18.115	18.123	18.130	2,810
2,820	18.130	18.138	18.146	18.154	18.161	18.169	18.177	18.185	18.192	18.200	18.208	2,820
2,830	18.208	18.216	18.223	18.231	18.239	18.247	18.255	18.262	18.270	18.278	18.286	2,830
2,840	18.286	18.293	18.301	18.309	18.317	18.324	18.332	18.340	18.348	18.355	18.363	2,840
2,850	18.363	18.371	18.379	18.386	18.394	18.402	18.410	18.417	18.425	18.433	18.441	2,850
2,860	18.441	18.448	18.456	18.464	18.472	18.479	18.487	18.495	18.502	18.510	18.518	2,860
2,870	18.518	18.526	18.533	18.541	18.549	18.557	18.564	18.572	18.580	18.588	18.595	2,870
2,880	18.595	18.603	18.611	18.619	18.626	18.634	18.642	18.649	18.657	18.665	18.673	2,880
2,890	18.673	18.680	18.688	18.696	18.703	18.711	18.719	18.727	18.734	18.742	18.750	2,890
2,900	18.750	18.758	18.765	18.773	18.781	18.788	18.796	18.804	18.812	18.819	18.827	2,900
2,910	18.827	18.835	18.842	18.850	18.858	18.865	18.873	18.881	18.889	18.896	18.904	2,910
2,920	18.904	18.912	18.919	18.927	18.935	18.943	18.950	18.958	18.966	18.973	18.981	2,920
2,930	18.981	18.989	18.996	19.004	19.012	19.019	19.027	19.035	19.043	19.050	19.058	2,930
2,940	19.058	19.066	19.073	19.081	19.089	19.096	19.104	19.112	19.119	19.127	19.135	2,940
2,950	19.135	19.142	19.150	19.158	19.165	19.173	19.181	19.188	19.196	19.204	19.211	2,950
2,960	19.211	19.219	19.227	19.234	19.242	19.250	19.257	19.265	19.273	19.280	19.288	2,960
2,970	19.288	19.296	19.303	19.311	19.319	19.326	19.334	19.342	19.349	19.357	19.365	2,970
2,980	19.365	19.372	19.380	19.388	19.395	19.403	19.411	19.418	19.426	19.434	19.441	2,980
2,990	19.441	19.449	19.457	19.464	19.472	19.479	19.487	19.495	19.502	19.510	19.518	2,990
3,000	19.518	19.525	19.533	19.541	19.548	19.556	19.563	19.571	19.579	19.586	19.594	3,000
3,010	19.594	19.602	19.609	19.617	19.624	19.632	19.640	19.647	19.655	19.663	19.670	3,010
3,020	19.670	19.678	19.685	19.693	19.701	19.708	19.716	19.723	19.731	19.739	19.746	3,020
3,030	19.746	19.754	19.761	19.769	19.777	19.784	19.792	19.800	19.807	19.815	19.822	3,030
3,040	19.822	19.830	19.837	19.845	19.853	19.860	19.868	19.875	19.883	19.891	19.898	3,040
3,050	19.898	19.906	19.913	19.921	19.929	19.936	19.944	19.951	19.959	19.966	19.974	3,050
3,060	19.974	19.982	19.989	19.997	20.004	20.012	20.019	20.027	20.034	20.042	20.050	3,060
3,070	20.050	20.057	20.065	20.072	20.080	20.087	20.095	20.102	20.110	20.117	20.125	3,070
3,080	20.125	20.132	20.140	20.148	20.155	20.163	20.170	20.178	20.185	20.193	20.200	3,080
3,090	20.200	20.208	20.215	20.223	20.230	20.238	20.245	20.253	20.260	20.268	20.275	3,090
3,100	20.275	20.283	20.290	20.297	20.305	20.312	20.320	20.327	20.335	20.342	20.350	3,100
3,110	20.350	20.357	20.365	20.372	20.380	20.387	20.394	20.402	20.409	20.417	20.424	3,110
3,120	20.424	20.432	20.439	20.446	20.454	20.461	20.469	20.476	20.483	20.491	20.498	3,120
3,130	20.498	20.506	20.513	20.520	20.528	20.535	20.543	20.550	20.557	20.565	20.572	3,130
3,140	20.572	20.579	20.587	20.594	20.601	20.609	20.616	20.623	20.631	20.638	20.645	3,140
3,150	20.645	20.653	20.660	20.667	20.675	20.682	20.689	20.697	20.704	20.711	20.718	3,150
3,160	20.718	20.726	20.733	20.740	20.748	20.755	20.762	20.769	20.777	20.784	20.791	3,160
3,170	20.791	20.798	20.806	20.813	20.820	20.827	20.834	20.842	20.849	20.856	20.863	3,170
3,180	20.863	20.870	20.878	20.885	20.892	20.899	20.906	20.914	20.921	20.928	20.935	3,180
3,190	20.935	20.942	20.949	20.956	20.964	20.971	20.978	20.985	20.992	20.999	21.006	3,190
3,200	21.006	21.013	21.021	21.028	21.035	21.042	21.049	21.056	21.063	21.070	21.077	3,200
3,210	21.077	21.084	21.091	21.098	21.105							3,210
DEG F	0	1	2	3	4	5	6	7	8	9	10	DEG F

* CONVERTED FROM DEGREES C(IPTS 1968).

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TABLE XIV

TYPE B

New Reference Tables
Supersedes N.B.S.
Circular #561

Platinum-6% Rhodium Vs. Platinum-30% Rhodium

Temperature in Degrees F
Reference Junction at 32°F

THERMOELECTRIC VOLTAGE IN ABSOLUTE MILLIVOLTS

DEG F	0	1	2	3	4	5	6	7	8	9	10	DEG F
0	0.006	0.006	0.006	0.006	0.005	0.005	0.005	0.005	0.004	0.004	0.004	0
10	0.004	0.004	0.003	0.003	0.003	0.003	0.003	0.002	0.002	0.002	0.002	10
20	0.002	0.002	0.002	0.001	0.001	0.001	0.001	0.001	0.001	0.000	0.000	20
30	0.000	0.000	0.000	-0.000	-0.000	-0.000	-0.001	-0.001	-0.001	-0.001	-0.001	30
40	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.002	-0.002	-0.002	-0.002	-0.002	40
50	-0.002	-0.002	-0.002	-0.002	-0.002	-0.002	-0.002	-0.002	-0.002	-0.002	-0.002	50
60	-0.002	-0.002	-0.002	-0.003	-0.003	-0.003	-0.003	-0.003	-0.003	-0.003	-0.003	60
70	-0.003	-0.003	-0.003	-0.003	-0.003	-0.003	-0.003	-0.002	-0.002	-0.002	-0.002	70
80	-0.002	-0.002	-0.002	-0.002	-0.002	-0.002	-0.002	-0.002	-0.002	-0.002	-0.002	80
90	-0.002	-0.002	-0.002	-0.002	-0.002	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	90
100	-0.001	-0.001	-0.001	-0.001	-0.000	-0.000	-0.000	-0.000	0.000	0.000	0.000	100
110	0.000	0.000	0.001	0.001	0.001	0.001	0.001	0.001	0.002	0.002	0.002	110
120	0.002	0.002	0.002	0.002	0.003	0.003	0.003	0.003	0.003	0.004	0.004	120
130	0.004	0.004	0.004	0.005	0.005	0.005	0.005	0.005	0.006	0.006	0.006	130
140	0.006	0.006	0.007	0.007	0.007	0.007	0.008	0.008	0.008	0.009	0.009	140
150	0.009	0.009	0.009	0.010	0.010	0.010	0.011	0.011	0.011	0.012	0.012	150
160	0.012	0.012	0.013	0.013	0.013	0.014	0.014	0.014	0.015	0.015	0.015	160
170	0.015	0.016	0.016	0.016	0.017	0.017	0.017	0.018	0.018	0.019	0.019	170
180	0.019	0.019	0.020	0.020	0.021	0.021	0.021	0.022	0.022	0.023	0.023	180
190	0.023	0.023	0.024	0.024	0.025	0.025	0.026	0.026	0.027	0.027	0.027	190
200	0.027	0.028	0.028	0.029	0.029	0.030	0.030	0.031	0.031	0.032	0.032	200
210	0.032	0.033	0.033	0.034	0.034	0.035	0.035	0.036	0.036	0.037	0.037	210
220	0.037	0.038	0.038	0.039	0.039	0.040	0.041	0.041	0.042	0.042	0.043	220
230	0.043	0.043	0.044	0.044	0.045	0.046	0.046	0.047	0.047	0.048	0.049	230
240	0.049	0.049	0.050	0.050	0.051	0.052	0.052	0.053	0.053	0.054	0.055	240
250	0.055	0.055	0.056	0.057	0.057	0.058	0.058	0.059	0.060	0.060	0.061	250
260	0.061	0.062	0.062	0.063	0.064	0.064	0.065	0.066	0.067	0.067	0.068	260
270	0.068	0.069	0.069	0.070	0.071	0.071	0.072	0.073	0.074	0.074	0.075	270
280	0.075	0.076	0.077	0.077	0.078	0.079	0.080	0.080	0.081	0.082	0.083	280
290	0.083	0.083	0.084	0.085	0.086	0.086	0.087	0.088	0.089	0.090	0.090	290
300	0.090	0.091	0.092	0.093	0.094	0.094	0.095	0.096	0.097	0.098	0.099	300
310	0.099	0.099	0.100	0.101	0.102	0.103	0.104	0.104	0.105	0.106	0.107	310
320	0.107	0.108	0.109	0.110	0.111	0.111	0.112	0.113	0.114	0.115	0.116	320
330	0.116	0.117	0.118	0.119	0.120	0.120	0.121	0.122	0.123	0.124	0.125	330
340	0.125	0.126	0.127	0.128	0.129	0.130	0.131	0.132	0.133	0.134	0.135	340
350	0.135	0.136	0.137	0.138	0.138	0.139	0.140	0.141	0.142	0.143	0.144	350
360	0.144	0.145	0.146	0.147	0.148	0.149	0.151	0.152	0.153	0.154	0.155	360
370	0.155	0.156	0.157	0.158	0.159	0.160	0.161	0.162	0.163	0.164	0.165	370
380	0.165	0.166	0.167	0.168	0.169	0.171	0.172	0.173	0.174	0.175	0.176	380
390	0.176	0.177	0.178	0.179	0.180	0.182	0.183	0.184	0.185	0.186	0.187	390
400	0.187	0.188	0.189	0.191	0.192	0.193	0.194	0.195	0.196	0.197	0.199	400
410	0.199	0.200	0.201	0.202	0.203	0.205	0.206	0.207	0.208	0.209	0.210	410
420	0.210	0.212	0.213	0.214	0.215	0.217	0.218	0.219	0.220	0.221	0.223	420
430	0.223	0.224	0.225	0.226	0.228	0.229	0.230	0.231	0.233	0.234	0.235	430
440	0.235	0.236	0.238	0.239	0.240	0.242	0.243	0.244	0.245	0.247	0.248	440
450	0.248	0.249	0.251	0.252	0.253	0.254	0.256	0.257	0.258	0.260	0.261	450
460	0.261	0.262	0.264	0.265	0.266	0.268	0.269	0.271	0.272	0.273	0.275	460
470	0.275	0.276	0.277	0.279	0.280	0.281	0.283	0.284	0.286	0.287	0.288	470
480	0.288	0.290	0.291	0.293	0.294	0.295	0.297	0.298	0.300	0.301	0.303	480
490	0.303	0.304	0.305	0.307	0.308	0.310	0.311	0.313	0.314	0.315	0.317	490
500	0.317	0.318	0.320	0.321	0.323	0.324	0.326	0.327	0.329	0.330	0.332	500
510	0.332	0.333	0.335	0.336	0.338	0.339	0.341	0.342	0.344	0.345	0.347	510
520	0.347	0.348	0.350	0.351	0.353	0.355	0.356	0.358	0.359	0.361	0.362	520
530	0.362	0.364	0.365	0.367	0.369	0.370	0.372	0.373	0.375	0.376	0.378	530
540	0.378	0.380	0.381	0.383	0.384	0.386	0.388	0.389	0.391	0.392	0.394	540
550	0.394	0.396	0.397	0.399	0.401	0.402	0.404	0.405	0.407	0.409	0.410	550
560	0.410	0.412	0.414	0.415	0.417	0.419	0.420	0.422	0.424	0.425	0.427	560
570	0.427	0.429	0.431	0.432	0.434	0.436	0.437	0.439	0.441	0.442	0.444	570
580	0.444	0.446	0.448	0.449	0.451	0.453	0.455	0.456	0.458	0.460	0.462	580
590	0.462	0.463	0.465	0.467	0.469	0.470	0.472	0.474	0.476	0.477	0.479	590
600	0.479	0.481	0.483	0.485	0.486	0.488	0.490	0.492	0.494	0.495	0.497	600
610	0.497	0.499	0.501	0.503	0.504	0.506	0.508	0.510	0.512	0.514	0.515	610
620	0.515	0.517	0.519	0.521	0.523	0.525	0.527	0.528	0.530	0.532	0.534	620
630	0.534	0.536	0.538	0.540	0.542	0.544	0.545	0.547	0.549	0.551	0.553	630
640	0.553	0.555	0.557	0.559	0.561	0.563	0.565	0.566	0.568	0.570	0.572	640
650	0.572	0.574	0.576	0.578	0.580	0.582	0.584	0.586	0.588	0.590	0.592	650
660	0.592	0.594	0.596	0.598	0.600	0.602	0.604	0.606	0.608	0.610	0.612	660
670	0.612	0.614	0.616	0.618	0.620	0.622	0.624	0.626	0.628	0.630	0.632	670
680	0.632	0.634	0.636	0.638	0.640	0.642	0.644	0.646	0.648	0.650	0.652	680
690	0.652	0.654	0.656	0.659	0.661	0.663	0.665	0.667	0.669	0.671	0.673	690
700	0.673	0.675	0.677	0.679	0.682	0.684	0.686	0.688	0.690	0.692	0.694	700
710	0.694	0.696	0.699	0.701	0.703	0.705	0.707	0.709	0.711	0.714	0.716	710
720	0.716	0.718	0.720	0.722	0.724	0.727	0.729	0.731	0.733	0.735	0.737	720
730	0.737	0.740	0.742	0.744	0.746	0.748	0.751	0.753	0.755	0.757	0.759	730
740	0.759	0.762	0.764	0.766	0.768	0.771	0.773	0.775	0.777	0.780	0.782	740
750	0.782	0.784	0.786	0.789	0.791	0.793	0.795	0.798	0.800	0.802	0.804	750
760	0.804	0.807	0.809	0.811	0.814	0.816	0.818	0.821	0.823	0.825	0.827	760
770	0.827	0.830	0.832	0.834	0.837	0.839	0.841	0.844	0.846	0.848	0.851	770
780	0.851	0.853	0.855	0.858	0.860	0.862	0.865	0.867	0.870	0.872	0.874	780
790	0.874	0.877	0.879	0.881	0.884	0.886	0.889	0.891	0.893	0.896	0.898	790
800	0.898	0.901	0.903	0.905	0.908	0.910	0.913	0.915	0.918	0.920	0.922	800
810	0.922	0.925	0.927	0.930	0.932	0.935	0.937	0.939	0.942	0.944	0.947	810
820	0.947	0.949	0.952	0.954	0.957	0.959	0.962	0.964	0.967	0.969	0.972	820
830	0.972	0.974	0.977	0.979	0.982	0.984	0.987	0.989	0.992	0.994	0.997	830
840	0.997	0.999	1.002	1.004	1.007	1.009	1.012	1.014	1.017	1.020	1.022	840
850	1.022	1.025	1.027	1.030	1.032	1.035	1.037	1.040	1.043	1.045	1.048	850
860	1.048	1.050	1.053	1.056	1.058	1.061	1.063	1.066	1.069	1.071	1.074	860
870	1.074	1.076	1.079	1.082	1.084	1.087	1.090	1.092	1.095	1.097	1.100	870
880	1.100	1.103	1.105	1.108	1.111	1.113	1.116	1.119	1.121	1.124	1.127	880
890	1.127	1.129	1.132	1.135	1.137	1.140	1.143	1.145	1.148	1.151	1.153	890
900	1.153	1.156	1.159	1.162	1.164	1.167	1.170	1.172	1.175	1.178	1.181	900
910	1.181	1.183	1.186	1.189	1.192	1.194	1.197	1.200	1.203	1.205	1.208	910
920	1.208	1.211	1.214	1.216	1.219	1.222	1.225	1.228	1.230	1.233	1.236	920
930	1.236	1.239	1.241	1.244	1.247	1.250	1.253	1.255	1.258	1.261	1.264	930
940	1.264	1.267	1.270	1.272	1.275	1.278	1.281	1.284	1.287	1.289	1.292	940
950	1.292	1.295	1.298	1.301	1.304	1.307	1.309	1.312	1.315	1.318	1.321	950
960	1.321	1.324	1.327	1.330	1.332	1.335	1.338	1.341	1.344	1.347	1.350	960
970	1.350	1.353	1.356	1.359	1.361	1.364	1.367	1.370	1.373	1.376	1.379	970
980	1.379	1.382	1.385	1.388	1.391	1.394	1.397	1.400	1.403	1.406	1.409	980
990	1.409	1.411	1.414	1.417	1.420	1.423	1.426	1.429	1.432	1.435	1.438	990
1,000	1.438	1.441	1.444	1.447	1.450	1.453	1.456	1.459	1.462	1.465	1.468	1,000
1,010	1.468	1.471	1.474	1.477	1.480	1.483	1.487	1.490	1.493	1.496	1.499	1,010
1,020	1.499	1.502	1.505	1.508	1.511	1.514	1.517	1.520	1.523	1.526	1.529	1,020
1,030	1.529	1.532	1.536	1.539	1.542	1.545	1.548	1.551	1.554	1.557	1.560	1,030
1,040	1.560	1.563	1.566	1.570	1.573	1.576	1.579	1.582	1.585	1.588	1.591	1,040
1,050	1.591	1.595	1.598	1.601	1.604	1.607	1.610	1.613	1.617	1.620	1.623	1,050
1,060	1.623	1.626	1.629	1.632	1.636	1.639	1.642	1.645	1.648	1.652	1.655	1,060
1,070	1.655	1.658	1.661	1.664	1.668	1.671	1.674	1.677	1.680	1.684	1.687	1,070
1,080	1.687	1.690	1.693	1.696	1.700	1.703	1.706	1.709	1.713	1.716	1.719	1,080
1,090	1.719	1.722	1.726	1.729	1.732	1.735	1.739	1.742	1.745	1.748	1.752	1,090
DEG F	0	1	2	3	4	5	6	7	8	9	10	DEG F

* CONVERTED FROM DEGREES C(IPTS 1968).

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TABLE XIV — Continued

TYPE B

New Reference Tables
Supersedes N.B.S.
Circular #561

Platinum-6% Rhodium Vs. Platinum-30% Rhodium

Temperature in Degrees F
Reference Junction at 32°F

THERMOELECTRIC VOLTAGE IN ABSOLUTE MILLIVOLTS

DEG F	0	1	2	3	4	5	6	7	8	9	10	DEG F
1,100	1.752	1.755	1.758	1.762	1.765	1.768	1.771	1.775	1.778	1.781	1.785	1,100
1,110	1.785	1.788	1.791	1.795	1.798	1.801	1.804	1.808	1.811	1.814	1.818	1,110
1,120	1.818	1.821	1.824	1.828	1.831	1.834	1.838	1.841	1.844	1.848	1.851	1,120
1,130	1.851	1.855	1.858	1.861	1.865	1.868	1.871	1.875	1.878	1.882	1.885	1,130
1,140	1.885	1.888	1.892	1.895	1.898	1.902	1.905	1.909	1.912	1.915	1.919	1,140
1,150	1.919	1.922	1.926	1.929	1.933	1.936	1.939	1.943	1.946	1.950	1.953	1,150
1,160	1.953	1.957	1.960	1.963	1.967	1.970	1.974	1.977	1.981	1.984	1.988	1,160
1,170	1.988	1.991	1.995	1.998	2.002	2.005	2.009	2.012	2.015	2.019	2.022	1,170
1,180	2.022	2.026	2.029	2.033	2.036	2.040	2.043	2.047	2.051	2.054	2.058	1,180
1,190	2.058	2.061	2.065	2.068	2.072	2.075	2.079	2.082	2.086	2.089	2.093	1,190
1,200	2.093	2.096	2.100	2.104	2.107	2.111	2.114	2.118	2.121	2.125	2.128	1,200
1,210	2.128	2.132	2.136	2.139	2.143	2.146	2.150	2.154	2.157	2.161	2.164	1,210
1,220	2.164	2.168	2.172	2.175	2.179	2.182	2.186	2.190	2.193	2.197	2.201	1,220
1,230	2.201	2.204	2.208	2.211	2.215	2.219	2.222	2.226	2.230	2.233	2.237	1,230
1,240	2.237	2.241	2.244	2.248	2.252	2.255	2.259	2.263	2.266	2.270	2.274	1,240
1,250	2.274	2.277	2.281	2.285	2.288	2.292	2.296	2.299	2.303	2.307	2.311	1,250
1,260	2.311	2.314	2.318	2.322	2.325	2.329	2.333	2.337	2.340	2.344	2.348	1,260
1,270	2.348	2.351	2.355	2.359	2.363	2.366	2.370	2.374	2.378	2.381	2.385	1,270
1,280	2.385	2.389	2.393	2.396	2.400	2.404	2.408	2.412	2.415	2.419	2.423	1,280
1,290	2.423	2.427	2.430	2.434	2.438	2.442	2.446	2.449	2.453	2.457	2.461	1,290
1,300	2.461	2.465	2.469	2.472	2.476	2.480	2.484	2.488	2.491	2.495	2.499	1,300
1,310	2.499	2.503	2.507	2.511	2.515	2.518	2.522	2.526	2.530	2.534	2.538	1,310
1,320	2.538	2.542	2.545	2.549	2.553	2.557	2.561	2.565	2.569	2.573	2.576	1,320
1,330	2.576	2.580	2.584	2.588	2.592	2.596	2.600	2.604	2.608	2.612	2.615	1,330
1,340	2.615	2.619	2.623	2.627	2.631	2.635	2.639	2.643	2.647	2.651	2.655	1,340
1,350	2.655	2.659	2.663	2.667	2.670	2.674	2.678	2.682	2.686	2.690	2.694	1,350
1,360	2.694	2.698	2.702	2.706	2.710	2.714	2.718	2.722	2.726	2.730	2.734	1,360
1,370	2.734	2.738	2.742	2.746	2.750	2.754	2.758	2.762	2.766	2.770	2.774	1,370
1,380	2.774	2.778	2.782	2.786	2.790	2.794	2.798	2.802	2.806	2.810	2.814	1,380
1,390	2.814	2.818	2.822	2.826	2.830	2.835	2.839	2.843	2.847	2.851	2.855	1,390
1,400	2.855	2.859	2.863	2.867	2.871	2.875	2.879	2.883	2.887	2.892	2.896	1,400
1,410	2.896	2.900	2.904	2.908	2.912	2.916	2.920	2.924	2.928	2.933	2.937	1,410
1,420	2.937	2.941	2.945	2.949	2.953	2.957	2.961	2.966	2.970	2.974	2.978	1,420
1,430	2.978	2.982	2.986	2.990	2.995	2.999	3.003	3.007	3.011	3.015	3.019	1,430
1,440	3.019	3.024	3.028	3.032	3.036	3.040	3.045	3.049	3.053	3.057	3.061	1,440
1,450	3.061	3.065	3.070	3.074	3.078	3.082	3.086	3.091	3.095	3.099	3.103	1,450
1,460	3.103	3.107	3.112	3.116	3.120	3.124	3.129	3.133	3.137	3.141	3.146	1,460
1,470	3.146	3.150	3.154	3.158	3.163	3.167	3.171	3.175	3.180	3.184	3.188	1,470
1,480	3.188	3.192	3.197	3.201	3.205	3.209	3.214	3.218	3.222	3.227	3.231	1,480
1,490	3.231	3.235	3.239	3.244	3.248	3.252	3.257	3.261	3.265	3.269	3.274	1,490
1,500	3.274	3.278	3.282	3.287	3.291	3.295	3.300	3.304	3.308	3.313	3.317	1,500
1,510	3.317	3.321	3.326	3.330	3.334	3.339	3.343	3.347	3.352	3.356	3.361	1,510
1,520	3.361	3.365	3.369	3.374	3.378	3.382	3.387	3.391	3.395	3.400	3.404	1,520
1,530	3.404	3.409	3.413	3.417	3.422	3.426	3.431	3.435	3.439	3.444	3.448	1,530
1,540	3.448	3.453	3.457	3.461	3.466	3.470	3.475	3.479	3.484	3.488	3.492	1,540
1,550	3.492	3.497	3.501	3.506	3.510	3.515	3.519	3.523	3.528	3.532	3.537	1,550
1,560	3.537	3.541	3.546	3.550	3.555	3.559	3.564	3.568	3.573	3.577	3.581	1,560
1,570	3.581	3.586	3.590	3.595	3.599	3.604	3.608	3.613	3.617	3.622	3.626	1,570
1,580	3.626	3.631	3.635	3.640	3.644	3.649	3.653	3.658	3.662	3.667	3.672	1,580
1,590	3.672	3.676	3.681	3.685	3.690	3.694	3.699	3.703	3.708	3.712	3.717	1,590
1,600	3.717	3.721	3.726	3.731	3.735	3.740	3.744	3.749	3.753	3.758	3.762	1,600
1,610	3.762	3.767	3.772	3.776	3.781	3.785	3.790	3.795	3.799	3.804	3.808	1,610
1,620	3.808	3.813	3.818	3.822	3.827	3.831	3.836	3.841	3.845	3.850	3.854	1,620
1,630	3.854	3.859	3.864	3.868	3.873	3.877	3.882	3.887	3.891	3.896	3.901	1,630
1,640	3.901	3.905	3.910	3.915	3.919	3.924	3.929	3.933	3.938	3.943	3.947	1,640
1,650	3.947	3.952	3.957	3.961	3.966	3.971	3.975	3.980	3.985	3.989	3.994	1,650
1,660	3.994	3.999	4.003	4.008	4.013	4.017	4.022	4.027	4.031	4.036	4.041	1,660
1,670	4.041	4.046	4.050	4.055	4.060	4.064	4.069	4.074	4.079	4.083	4.088	1,670
1,680	4.088	4.093	4.098	4.102	4.107	4.112	4.117	4.121	4.126	4.131	4.136	1,680
1,690	4.136	4.140	4.145	4.150	4.155	4.159	4.164	4.169	4.174	4.178	4.183	1,690
1,700	4.183	4.188	4.193	4.198	4.202	4.207	4.212	4.217	4.221	4.226	4.231	1,700
1,710	4.231	4.236	4.241	4.245	4.250	4.255	4.260	4.265	4.269	4.274	4.279	1,710
1,720	4.279	4.284	4.289	4.294	4.298	4.303	4.308	4.313	4.318	4.323	4.327	1,720
1,730	4.327	4.332	4.337	4.342	4.347	4.352	4.357	4.361	4.366	4.371	4.376	1,730
1,740	4.376	4.381	4.386	4.391	4.395	4.400	4.405	4.410	4.415	4.420	4.425	1,740
1,750	4.425	4.430	4.435	4.439	4.444	4.449	4.454	4.459	4.464	4.469	4.474	1,750
1,760	4.474	4.479	4.484	4.488	4.493	4.498	4.503	4.508	4.513	4.518	4.523	1,760
1,770	4.523	4.528	4.533	4.538	4.543	4.548	4.552	4.557	4.562	4.567	4.572	1,770
1,780	4.572	4.577	4.582	4.587	4.592	4.597	4.602	4.607	4.612	4.617	4.622	1,780
1,790	4.622	4.627	4.632	4.637	4.642	4.647	4.652	4.657	4.662	4.667	4.672	1,790
1,800	4.672	4.677	4.682	4.687	4.692	4.697	4.702	4.707	4.712	4.717	4.722	1,800
1,810	4.722	4.727	4.732	4.737	4.742	4.747	4.752	4.757	4.762	4.767	4.772	1,810
1,820	4.772	4.777	4.782	4.787	4.792	4.797	4.802	4.807	4.812	4.817	4.823	1,820
1,830	4.823	4.828	4.833	4.838	4.843	4.848	4.853	4.858	4.863	4.868	4.873	1,830
1,840	4.873	4.878	4.883	4.888	4.894	4.899	4.904	4.909	4.914	4.919	4.924	1,840
1,850	4.924	4.929	4.934	4.939	4.945	4.950	4.955	4.960	4.965	4.970	4.975	1,850
1,860	4.975	4.980	4.985	4.991	4.996	5.001	5.006	5.011	5.016	5.021	5.027	1,860
1,870	5.027	5.032	5.037	5.042	5.047	5.052	5.057	5.063	5.068	5.073	5.078	1,870
1,880	5.078	5.083	5.088	5.094	5.099	5.104	5.109	5.114	5.119	5.125	5.130	1,880
1,890	5.130	5.135	5.140	5.145	5.150	5.156	5.161	5.166	5.171	5.176	5.182	1,890
1,900	5.182	5.187	5.192	5.197	5.202	5.208	5.213	5.218	5.223	5.229	5.234	1,900
1,910	5.234	5.239	5.244	5.249	5.255	5.260	5.265	5.270	5.276	5.281	5.286	1,910
1,920	5.286	5.291	5.297	5.302	5.307	5.312	5.318	5.323	5.328	5.333	5.339	1,920
1,930	5.339	5.344	5.349	5.354	5.360	5.365	5.370	5.376	5.381	5.386	5.391	1,930
1,940	5.391	5.397	5.402	5.407	5.413	5.418	5.423	5.428	5.434	5.439	5.444	1,940
1,950	5.444	5.450	5.455	5.460	5.466	5.471	5.476	5.482	5.487	5.492	5.497	1,950
1,960	5.497	5.503	5.508	5.513	5.519	5.524	5.529	5.535	5.540	5.545	5.551	1,960
1,970	5.551	5.556	5.561	5.567	5.572	5.578	5.583	5.588	5.594	5.599	5.604	1,970
1,980	5.604	5.610	5.615	5.620	5.626	5.631	5.637	5.642	5.647	5.653	5.658	1,980
1,990	5.658	5.663	5.669	5.674	5.680	5.685	5.690	5.696	5.701	5.707	5.712	1,990
2,000	5.712	5.717	5.723	5.728	5.734	5.739	5.744	5.750	5.755	5.761	5.766	2,000
2,010	5.766	5.771	5.777	5.782	5.788	5.793	5.799	5.804	5.810	5.815	5.820	2,010
2,020	5.820	5.826	5.831	5.837	5.842	5.848	5.853	5.859	5.864	5.869	5.875	2,020
2,030	5.875	5.880	5.886	5.891	5.897	5.902	5.908	5.913	5.919	5.924	5.930	2,030
2,040	5.930	5.935	5.941	5.946	5.951	5.957	5.962	5.968	5.973	5.979	5.984	2,040
2,050	5.984	5.990	5.995	6.001	6.006	6.012	6.017	6.023	6.028	6.034	6.039	2,050
2,060	6.039	6.045	6.051	6.056	6.062	6.067	6.073	6.078	6.084	6.089	6.095	2,060
2,070	6.095	6.100	6.106	6.111	6.117	6.122	6.128	6.134	6.139	6.145	6.150	2,070
2,080	6.150	6.156	6.161	6.167	6.172	6.178	6.184	6.189	6.195	6.200	6.206	2,080
2,090	6.206	6.211	6.217	6.223	6.228	6.234	6.239	6.245	6.250	6.256	6.262	2,090
2,100	6.262	6.267	6.273	6.278	6.284	6.290	6.295	6.301	6.306	6.312	6.318	2,100
2,110	6.318	6.323	6.329	6.334	6.340	6.346	6.351	6.357	6.362	6.368	6.374	2,110
2,120	6.374	6.379	6.385	6.391	6.396	6.402	6.408	6.413	6.419	6.424	6.430	2,120
2,130	6.430	6.436	6.441	6.447	6.453	6.458	6.464	6.470	6.475	6.481	6.487	2,130
2,140	6.487	6.492	6.498	6.504	6.509	6.515	6.521	6.526	6.532	6.538	6.543	2,140
2,150	6.543	6.549	6.555	6.560	6.566	6.572	6.577	6.583	6.589	6.594	6.600	2,150
2,160	6.600	6.606	6.612	6.617	6.623	6.629	6.634	6.640	6.646	6.651	6.657	2,160
2,170	6.657	6.663	6.669	6.674	6.680	6.686	6.692	6.697	6.703	6.709	6.714	2,170
2,180	6.714	6.720	6.726	6.732	6.737	6.743	6.749	6.755	6.760	6.766	6.772	2,180
2,190	6.772	6.778	6.783	6.789	6.795	6.801	6.806	6.812	6.818	6.824	6.829	2,190
DEG F	0	1	2	3	4	5	6	7	8	9	10	DEG F

* CONVERTED FROM DEGREES C(IPTS 1968).

OMEGA ENGINEERING, INC.
An OMEGA Group Company
One Omega Drive, Box 4047, Stamford, CT 06907
(203) 359-1660 Telex 996404 Cable OMEGA

TABLE XIV—Continued

TYPE B

New Reference Tables
Supersedes N.B.S.
Circular #561

Platinum-6% Rhodium Vs. Platinum-30% Rhodium

Temperature in Degrees F
Reference Junction at 32°F

THERMOELECTRIC VOLTAGE IN ABSOLUTE MILLIVOLTS

DEG F	0	1	2	3	4	5	6	7	8	9	10	DEG F
2,200	6.829	6.835	6.841	6.847	6.852	6.858	6.864	6.870	6.876	6.881	6.887	2,200
2,210	6.887	6.893	6.899	6.904	6.910	6.916	6.922	6.928	6.933	6.939	6.945	2,210
2,220	6.945	6.951	6.957	6.962	6.968	6.974	6.980	6.986	6.991	6.997	7.003	2,220
2,230	7.003	7.009	7.015	7.021	7.026	7.032	7.038	7.044	7.050	7.055	7.061	2,230
2,240	7.061	7.067	7.073	7.079	7.085	7.090	7.096	7.102	7.108	7.114	7.120	2,240
2,250	7.120	7.126	7.131	7.137	7.143	7.149	7.155	7.161	7.167	7.172	7.178	2,250
2,260	7.178	7.184	7.190	7.196	7.202	7.208	7.213	7.219	7.225	7.231	7.237	2,260
2,270	7.237	7.243	7.249	7.255	7.260	7.266	7.272	7.278	7.284	7.290	7.296	2,270
2,280	7.296	7.302	7.308	7.314	7.319	7.325	7.331	7.337	7.343	7.349	7.355	2,280
2,290	7.355	7.361	7.367	7.373	7.378	7.384	7.390	7.396	7.402	7.408	7.414	2,290
2,300	7.414	7.420	7.426	7.432	7.438	7.444	7.450	7.456	7.461	7.467	7.473	2,300
2,310	7.473	7.479	7.485	7.491	7.497	7.503	7.509	7.515	7.521	7.527	7.533	2,310
2,320	7.533	7.539	7.545	7.551	7.557	7.563	7.569	7.575	7.581	7.587	7.592	2,320
2,330	7.592	7.598	7.604	7.610	7.616	7.622	7.628	7.634	7.640	7.646	7.652	2,330
2,340	7.652	7.658	7.664	7.670	7.676	7.682	7.688	7.694	7.700	7.706	7.712	2,340
2,350	7.712	7.718	7.724	7.730	7.736	7.742	7.748	7.754	7.760	7.766	7.772	2,350
2,360	7.772	7.778	7.784	7.790	7.796	7.802	7.808	7.814	7.820	7.827	7.833	2,360
2,370	7.833	7.839	7.845	7.851	7.857	7.863	7.869	7.875	7.881	7.887	7.893	2,370
2,380	7.893	7.899	7.905	7.911	7.917	7.923	7.929	7.935	7.941	7.947	7.953	2,380
2,390	7.953	7.959	7.966	7.972	7.978	7.984	7.990	7.996	8.002	8.008	8.014	2,390
2,400	8.014	8.020	8.026	8.032	8.038	8.044	8.051	8.057	8.063	8.069	8.075	2,400
2,410	8.075	8.081	8.087	8.093	8.099	8.105	8.111	8.118	8.124	8.130	8.136	2,410
2,420	8.136	8.142	8.148	8.154	8.160	8.166	8.172	8.179	8.185	8.191	8.197	2,420
2,430	8.197	8.203	8.209	8.215	8.221	8.227	8.234	8.240	8.246	8.252	8.258	2,430
2,440	8.258	8.264	8.270	8.276	8.283	8.289	8.295	8.301	8.307	8.313	8.319	2,440
2,450	8.319	8.326	8.332	8.338	8.344	8.350	8.356	8.362	8.369	8.375	8.381	2,450
2,460	8.381	8.387	8.393	8.399	8.405	8.412	8.418	8.424	8.430	8.436	8.442	2,460
2,470	8.442	8.449	8.455	8.461	8.467	8.473	8.479	8.486	8.492	8.498	8.504	2,470
2,480	8.504	8.510	8.516	8.523	8.529	8.535	8.541	8.547	8.554	8.560	8.566	2,480
2,490	8.566	8.572	8.578	8.585	8.591	8.597	8.603	8.609	8.616	8.622	8.628	2,490
2,500	8.628	8.634	8.640	8.647	8.653	8.659	8.665	8.671	8.678	8.684	8.690	2,500
2,510	8.690	8.696	8.702	8.709	8.715	8.721	8.727	8.733	8.740	8.746	8.752	2,510
2,520	8.752	8.758	8.765	8.771	8.777	8.783	8.790	8.796	8.802	8.808	8.814	2,520
2,530	8.814	8.821	8.827	8.833	8.839	8.846	8.852	8.858	8.864	8.871	8.877	2,530
2,540	8.877	8.883	8.889	8.896	8.902	8.908	8.914	8.921	8.927	8.933	8.939	2,540
2,550	8.939	8.946	8.952	8.958	8.964	8.971	8.977	8.983	8.989	8.996	9.002	2,550
2,560	9.002	9.008	9.015	9.021	9.027	9.033	9.040	9.046	9.052	9.058	9.065	2,560
2,570	9.065	9.071	9.077	9.084	9.090	9.096	9.102	9.109	9.115	9.121	9.128	2,570
2,580	9.128	9.134	9.140	9.146	9.153	9.159	9.165	9.172	9.178	9.184	9.191	2,580
2,590	9.191	9.197	9.203	9.209	9.216	9.222	9.228	9.235	9.241	9.247	9.254	2,590
2,600	9.254	9.260	9.266	9.273	9.279	9.285	9.291	9.298	9.304	9.310	9.317	2,600
2,610	9.317	9.323	9.329	9.336	9.342	9.348	9.355	9.361	9.367	9.374	9.380	2,610
2,620	9.380	9.386	9.393	9.399	9.405	9.412	9.418	9.424	9.431	9.437	9.443	2,620
2,630	9.443	9.450	9.456	9.462	9.469	9.475	9.481	9.488	9.494	9.500	9.507	2,630
2,640	9.507	9.513	9.519	9.526	9.532	9.538	9.545	9.551	9.558	9.564	9.570	2,640
2,650	9.570	9.577	9.583	9.589	9.596	9.602	9.608	9.615	9.621	9.627	9.634	2,650
2,660	9.634	9.640	9.647	9.653	9.659	9.666	9.672	9.678	9.685	9.691	9.697	2,660
2,670	9.697	9.704	9.710	9.717	9.723	9.729	9.736	9.742	9.748	9.755	9.761	2,670
2,680	9.761	9.768	9.774	9.780	9.787	9.793	9.800	9.806	9.812	9.819	9.825	2,680
2,690	9.825	9.831	9.838	9.844	9.851	9.857	9.863	9.870	9.876	9.883	9.889	2,690
2,700	9.889	9.895	9.902	9.908	9.915	9.921	9.927	9.934	9.940	9.947	9.953	2,700
2,710	9.953	9.959	9.966	9.972	9.979	9.985	9.991	9.998	10.004	10.011	10.017	2,710
2,720	10.017	10.023	10.030	10.036	10.043	10.049	10.056	10.062	10.068	10.075	10.081	2,720
2,730	10.081	10.088	10.094	10.100	10.107	10.113	10.120	10.126	10.133	10.139	10.145	2,730
2,740	10.145	10.152	10.158	10.165	10.171	10.178	10.184	10.190	10.197	10.203	10.210	2,740
2,750	10.210	10.216	10.223	10.229	10.235	10.242	10.248	10.255	10.261	10.268	10.274	2,750
2,760	10.274	10.280	10.287	10.293	10.300	10.306	10.313	10.319	10.325	10.332	10.338	2,760
2,770	10.338	10.345	10.351	10.358	10.364	10.371	10.377	10.383	10.390	10.396	10.403	2,770
2,780	10.403	10.409	10.416	10.422	10.429	10.435	10.441	10.448	10.454	10.461	10.467	2,780
2,790	10.467	10.474	10.480	10.487	10.493	10.500	10.506	10.512	10.519	10.525	10.532	2,790
2,800	10.532	10.538	10.545	10.551	10.558	10.564	10.571	10.577	10.584	10.590	10.596	2,800
2,810	10.596	10.603	10.609	10.616	10.622	10.629	10.635	10.642	10.648	10.655	10.661	2,810
2,820	10.661	10.668	10.674	10.680	10.687	10.693	10.700	10.706	10.713	10.719	10.726	2,820
2,830	10.726	10.732	10.739	10.745	10.752	10.758	10.765	10.771	10.778	10.784	10.790	2,830
2,840	10.790	10.797	10.803	10.810	10.816	10.823	10.829	10.836	10.842	10.849	10.855	2,840
2,850	10.855	10.862	10.868	10.875	10.881	10.888	10.894	10.901	10.907	10.914	10.920	2,850
2,860	10.920	10.926	10.933	10.939	10.946	10.952	10.959	10.965	10.972	10.978	10.985	2,860
2,870	10.985	10.991	10.998	11.004	11.011	11.017	11.024	11.030	11.037	11.043	11.050	2,870
2,880	11.050	11.056	11.063	11.069	11.076	11.082	11.089	11.095	11.102	11.108	11.115	2,880
2,890	11.115	11.121	11.128	11.134	11.141	11.147	11.154	11.160	11.166	11.173	11.179	2,890
2,900	11.179	11.186	11.192	11.199	11.205	11.212	11.218	11.225	11.231	11.238	11.244	2,900
2,910	11.244	11.251	11.257	11.264	11.270	11.277	11.283	11.290	11.296	11.303	11.309	2,910
2,920	11.309	11.316	11.322	11.329	11.335	11.342	11.348	11.355	11.361	11.368	11.374	2,920
2,930	11.374	11.381	11.387	11.394	11.400	11.407	11.413	11.420	11.426	11.433	11.439	2,930
2,940	11.439	11.446	11.452	11.459	11.465	11.472	11.478	11.485	11.491	11.498	11.504	2,940
2,950	11.504	11.511	11.517	11.524	11.530	11.537	11.543	11.550	11.556	11.563	11.569	2,950
2,960	11.569	11.576	11.582	11.589	11.595	11.602	11.608	11.615	11.621	11.628	11.634	2,960
2,970	11.634	11.641	11.647	11.654	11.660	11.667	11.673	11.680	11.686	11.693	11.699	2,970
2,980	11.699	11.706	11.712	11.719	11.725	11.732	11.738	11.745	11.751	11.758	11.764	2,980
2,990	11.764	11.771	11.777	11.784	11.790	11.797	11.803	11.810	11.816	11.823	11.829	2,990
3,000	11.829	11.836	11.842	11.849	11.855	11.862	11.868	11.875	11.881	11.888	11.894	3,000
3,010	11.894	11.901	11.907	11.914	11.920	11.927	11.933	11.940	11.946	11.953	11.959	3,010
3,020	11.959	11.966	11.972	11.979	11.985	11.992	11.998	12.005	12.011	12.018	12.024	3,020
3,030	12.024	12.031	12.037	12.044	12.050	12.057	12.063	12.070	12.076	12.083	12.089	3,030
3,040	12.089	12.096	12.102	12.109	12.115	12.121	12.128	12.134	12.141	12.147	12.154	3,040
3,050	12.154	12.160	12.167	12.173	12.180	12.186	12.193	12.199	12.206	12.212	12.219	3,050
3,060	12.219	12.225	12.232	12.238	12.245	12.251	12.258	12.264	12.271	12.277	12.284	3,060
3,070	12.284	12.290	12.297	12.303	12.310	12.316	12.323	12.329	12.336	12.342	12.349	3,070
3,080	12.349	12.355	12.362	12.368	12.374	12.381	12.387	12.394	12.400	12.407	12.413	3,080
3,090	12.413	12.420	12.426	12.433	12.439	12.446	12.452	12.459	12.465	12.472	12.478	3,090
3,100	12.478	12.485	12.491	12.498	12.504	12.511	12.517	12.523	12.530	12.536	12.543	3,100
3,110	12.543	12.549	12.556	12.562	12.569	12.575	12.582	12.588	12.595	12.601	12.608	3,110
3,120	12.608	12.614	12.621	12.627	12.633	12.640	12.646	12.653	12.659	12.666	12.672	3,120
3,130	12.672	12.679	12.685	12.692	12.698	12.705	12.711	12.718	12.724	12.730	12.737	3,130
3,140	12.737	12.743	12.750	12.756	12.763	12.769	12.776	12.782	12.789	12.795	12.801	3,140
3,150	12.801	12.808	12.814	12.821	12.827	12.834	12.840	12.847	12.853	12.860	12.866	3,150
3,160	12.866	12.872	12.879	12.385	12.892	12.898	12.905	12.911	12.918	12.924	12.930	3,160
3,170	12.930	12.937	12.943	12.950	12.956	12.963	12.969	12.976	12.982	12.988	12.995	3,170
3,180	12.995	13.001	13.008	13.014	13.021	13.027	13.034	13.040	13.046	13.053	13.059	3,180
3,190	13.059	13.066	13.072	13.079	13.085	13.091	13.098	13.104	13.111	13.117	13.124	3,190
3,200	13.124	13.130	13.136	13.143	13.149	13.156	13.162	13.169	13.175	13.181	13.188	3,200
3,210	13.188	13.194	13.201	13.207	13.213	13.220	13.226	13.233	13.239	13.246	13.252	3,210
3,220	13.252	13.258	13.265	13.271	13.278	13.284	13.290	13.297	13.303	13.310	13.316	3,220
3,230	13.316	13.322	13.329	13.335	13.342	13.348	13.354	13.361	13.367	13.374	13.380	3,230
3,240	13.380	13.387	13.393	13.399	13.406	13.412	13.418	13.425	13.431	13.438	13.444	3,240
3,250	13.444	13.450	13.457	13.463	13.470	13.476	13.482	13.489	13.495	13.502	13.508	3,250
3,260	13.508	13.514	13.521	13.527	13.533	13.540	13.546	13.553	13.559	13.565	13.572	3,260
3,270	13.572	13.578	13.585	13.591	13.597	13.604	13.610	13.616	13.623	13.629	13.635	3,270
3,280	13.635	13.642	13.648	13.655	13.661	13.667	13.674	13.680	13.686	13.693	13.699	3,280
3,290	13.699	13.706	13.712	13.718	13.725	13.731	13.737	13.744	13.750	13.756	13.763	3,290
3,300	13.763	13.769	13.775	13.782	13.788	13.794	13.801	13.807	13.814			3,300
DEG F	0	1	2	3	4	5	6	7	8	9	10	DEG F

* CONVERTED FROM DEGREES C(IPTS 1968).

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TABLE XV Tungsten Vs. Tungsten-26% Rhenium

Temperature in Degrees F

Reference Junction at 32°F

DEGREES F.	0°	20°	40°	60°	80°	DEGREES F.	0°	20°	40°	60°	80°
0°	–.016	–.007	0.006	0.026	0.050	2200°	18.701	18.936	19.170	19.405	19.639
100°	0.079	0.113	0.153	0.197	0.246	2300°	19.873	20.106	20.340	20.573	20.806
200°	0.299	0.357	0.420	0.487	0.559	2400°	21.038	21.270	21.502	21.734	21.965
300°	0.634	0.714	0.799	0.887	0.979	2500°	22.195	22.425	22.655	22.884	23.113
400°	1.075	1.175	1.279	1.387	1.498	2600°	23.341	23.569	23.796	24.023	24.249
500°	1.613	1.731	1.853	1.978	2.106	2700°	24.474	24.699	24.923	25.146	25.369
600°	2.238	2.373	2.511	2.652	2.796	2800°	25.591	25.812	26.033	26.253	26.472
700°	2.943	3.093	3.246	3.401	3.559	2900°	26.690	26.907	27.124	27.340	27.555
800°	3.720	3.884	4.049	4.218	4.389	3000°	27.769	27.983	28.195	28.407	28.618
900°	4.562	4.737	4.915	5.095	5.277	3100°	28.827	29.036	29.244	29.451	29.657
1000°	5.461	5.647	5.836	6.026	6.218	3200°	29.862	30.066	30.269	30.471	30.672
1100°	6.412	6.607	6.805	7.004	7.205	3300°	30.871	31.070	31.268	31.464	31.660
1200°	7.407	7.611	7.816	8.023	8.232	3400°	31.854	32.047	32.240	32.430	32.620
1300°	8.441	8.652	8.865	9.078	9.293	3500°	32.809	32.996	33.182	33.367	33.551
1400°	9.509	9.726	9.945	10.164	10.384	3600°	33.733	33.914	34.094	34.273	34.450
1500°	10.606	10.828	11.051	11.275	11.500	3700°	34.626	34.801	34.974	35.146	35.317
1600°	11.725	11.952	12.179	12.407	12.635	3800°	35.486	35.654	35.821	35.986	36.150
1700°	12.864	13.094	13.324	13.555	13.786	3900°	36.312	36.473	36.632	36.790	36.946
1800°	14.018	14.250	14.482	14.715	14.948	4000°	37.101	37.254	37.406	37.557	37.705
1900°	15.182	15.415	15.649	15.884	16.118	4100°	37.853	37.998	38.142	38.285	38.425
2000°	16.353	16.587	16.822	17.057	17.292	4200°	38.564				
2100°	17.527	17.762	17.997	18.232	18.467						

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TABLE XVI Tungsten-5% Rhenium Vs. Tungsten-26% Rhenium

Temperature in Degrees F

Reference Junction at 32°F

DEGREES F.	0°	20°	40°	60°	80°	DEGREES F.	0°	20°	40°	60°	80°
0°	–.234	–.089	0.059	0.211	0.365	2200°	21.896	22.087	22.277	22.466	22.655
100°	0.522	0.682	0.845	1.010	1.178	2300°	22.843	23.030	23.217	23.403	23.588
200°	1.348	1.520	1.695	1.872	2.051	2400°	23.772	23.956	24.138	24.320	24.502
300°	2.232	2.415	2.600	2.786	2.975	2500°	24.682	24.862	25.041	25.219	25.397
400°	3.165	3.357	3.551	3.746	3.942	2600°	25.574	25.750	25.925	26.100	26.274
500°	4.140	4.339	4.540	4.742	4.945	2700°	26.447	26.619	26.791	26.962	27.132
600°	5.149	5.354	5.560	5.767	5.975	2800°	27.301	27.470	27.637	27.805	27.971
700°	6.184	6.394	6.604	6.815	7.027	2900°	28.137	28.301	28.466	28.629	28.791
800°	7.240	7.453	7.667	7.881	8.095	3000°	28.953	29.114	29.275	29.434	29.593
900°	8.310	8.526	8.741	8.957	9.174	3100°	29.751	29.908	30.065	30.221	30.376
1000°	9.390	9.607	9.824	10.041	10.258	3200°	30.530	30.683	30.836	30.988	31.139
1100°	10.475	10.693	10.910	11.127	11.344	3300°	31.289	31.438	31.587	31.735	31.882
1200°	11.561	11.778	11.995	12.212	12.429	3400°	32.028	32.173	32.318	32.461	32.604
1300°	12.645	12.861	13.077	13.292	13.508	3500°	32.746	32.887	33.027	33.166	33.305
1400°	13.723	13.937	14.152	14.366	14.579	3600°	33.442	33.579	33.714	33.849	33.982
1500°	14.792	15.005	15.217	15.429	15.640	3700°	34.115	34.247	34.378	34.507	34.636
1600°	15.851	16.062	16.271	16.481	16.689	3800°	34.763	34.890	35.015	35.140	35.263
1700°	16.898	17.105	17.312	17.519	17.725	3900°	35.385	35.506	35.626	35.744	35.862
1800°	17.930	18.134	18.339	18.542	18.745	4000°	35.978	36.093	36.206	36.319	36.430
1900°	18.947	19.148	19.349	19.549	19.748	4100°	36.539	36.647	36.754	36.860	36.964
2000°	19.947	20.145	20.343	20.539	20.735	4200°	37.066				
2100°	20.930	21.125	21.319	21.512	21.704						

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TABLE XVII Tungsten-3% Rhenium Vs. Tungsten-25% Rhenium

Temperature in Degrees F

Reference Junction at 32°F

DEGREES F.	0°	20°	40°	60°	80°	DEGREES F.	0°	20°	40°	60°	80°
0°	–.163	–.063	0.043	0.154	0.269	2200°	22.228	22.440	22.651	22.863	23.073
100°	0.390	0.515	0.644	0.778	0.916	2300°	23.283	23.492	23.701	23.909	24.116
200°	1.058	1.204	1.354	1.507	1.664	2400°	24.323	24.529	24.735	24.940	25.145
300°	1.824	1.988	2.154	2.324	2.497	2500°	25.348	25.551	25.754	25.956	26.157
400°	2.673	2.851	3.032	3.216	3.402	2600°	26.358	26.558	26.757	26.956	27.154
500°	3.590	3.781	3.973	4.168	4.365	2700°	27.352	27.548	27.745	27.940	28.135
600°	4.564	4.765	4.967	5.171	5.377	2800°	28.329	28.523	28.715	28.908	29.099
700°	5.584	5.793	6.003	6.214	6.427	2900°	29.290	29.480	29.669	29.858	30.046
800°	6.640	6.855	7.071	7.288	7.506	3000°	30.233	30.419	30.605	30.790	30.974
900°	7.725	7.945	8.165	8.386	8.608	3100°	31.158	31.340	31.522	31.703	31.884
1000°	8.830	9.053	9.277	9.501	9.726	3200°	32.063	32.242	32.420	32.596	32.772
1100°	9.951	10.176	10.402	10.628	10.854	3300°	32.948	33.122	33.295	33.467	33.639
1200°	11.080	11.307	11.534	11.761	11.988	3400°	33.809	33.979	34.147	34.314	34.481
1300°	12.215	12.443	12.670	12.897	13.125	3500°	34.646	34.810	34.973	35.135	35.295
1400°	13.352	13.579	13.807	14.034	14.262	3600°	35.455	35.613	35.770	35.926	36.080
1500°	14.489	14.717	14.944	15.171	15.398	3700°	36.233	36.384	36.535	36.683	36.831
1600°	15.624	15.850	16.076	16.302	16.527	3800°	36.976	37.120	37.263	37.404	37.543
1700°	16.752	16.976	17.200	17.424	17.647	3900°	37.681	37.816	37.950	38.082	38.213
1800°	17.870	18.093	18.315	18.537	18.758	4000°	38.341	38.467	38.591	38.714	38.834
1900°	18.979	19.199	19.419	19.638	19.857	4100°	38.951	39.067	39.180	39.291	39.400
2000°	20.075	20.293	20.510	20.726	20.943	4200°	39.506				
2100°	21.158	21.373	21.588	21.802	22.015						

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TABLE XVIII Temperature Vs. Resistance Table

For European Curve, Alpha = .00385

1° Celsius Increments

°C	Ohm	Diff.	°C	Ohm	Diff.	°C	Ohm	Diff.	°C	Ohm	Diff.	°C	Ohm	Diff.	°C	Ohm	Diff.
– 200	18.49		– 140	43.87	0.42	– 80	68.33	0.41	– 20	92.16	0.39	± 0	100.00	0.39	+ 60	123.24	0.38
199	18.93	0.44	139	44.28	0.41	79	68.73	0.40	19	92.55	0.39	+ 1	100.39	0.39	61	123.62	0.38
198	19.36	0.43	138	44.70	0.42	78	69.13	0.40	18	92.95	0.40	2	100.78	0.39	62	124.01	0.39
197	19.79	0.43	137	45.11	0.41	77	69.53	0.40	17	93.34	0.39	3	101.17	0.39	63	124.39	0.38
196	20.22	0.43	136	45.52	0.41	76	69.93	0.40	16	93.73	0.39	4	101.56	0.39	64	124.77	0.38
195	20.65	0.43	135	45.94	0.42	75	70.33	0.40	15	94.12	0.39	5	101.95	0.39	65	125.16	0.39
194	21.08	0.43	134	46.35	0.41	74	70.73	0.40	14	94.52	0.40	6	102.34	0.39	66	125.54	0.38
193	21.51	0.43	133	46.76	0.41	73	71.13	0.40	13	94.91	0.39	7	102.73	0.39	67	125.92	0.38
192	21.94	0.43	132	47.18	0.42	72	71.53	0.40	12	95.30	0.39	8	103.12	0.39	68	126.31	0.39
191	22.37	0.43	131	47.59	0.41	71	71.93	0.40	11	95.69	0.39	9	103.51	0.39	69	126.69	0.38
190	22.80	0.43	130	48.00	0.41	70	72.33	0.40	10	96.09	0.40	10	103.90	0.39	70	127.07	0.38
189	23.23	0.43	129	48.41	0.41	69	72.73	0.40	9	96.48	0.39	11	104.29	0.39	71	127.45	0.38
188	23.66	0.43	128	48.82	0.41	68	73.13	0.40	8	96.87	0.39	12	104.68	0.39	72	127.84	0.39
187	24.09	0.43	127	49.23	0.41	67	73.53	0.40	7	97.26	0.39	13	105.07	0.39	73	128.22	0.38
186	24.52	0.43	126	49.64	0.41	66	73.93	0.40	6	97.65	0.39	14	105.46	0.39	74	128.60	0.38
185	24.94	0.42	125	50.06	0.42	65	74.33	0.40	5	98.04	0.39	15	105.85	0.39	75	128.98	0.38
184	25.37	0.43	124	50.47	0.41	64	74.73	0.40	4	98.44	0.40	16	106.24	0.39	76	129.37	0.39
183	25.80	0.43	123	50.88	0.41	63	75.13	0.40	3	98.83	0.39	17	106.63	0.39	77	129.75	0.38
182	26.23	0.43	122	51.29	0.41	62	75.53	0.40	2	99.22	0.39	18	107.02	0.39	78	130.13	0.38
181	26.65	0.42	121	51.70	0.41	61	75.93	0.40	1	99.61	0.39	19	107.40	0.38	79	130.51	0.38
180	27.08	0.43	120	52.11	0.41	60	76.33	0.40				20	107.79	0.39	80	130.89	0.38
179	27.50	0.42	119	52.52	0.41	59	76.73	0.40				21	108.18	0.39	81	131.27	0.38
178	27.93	0.43	118	52.92	0.40	58	77.13	0.40				22	108.57	0.39	82	131.66	0.39
177	28.35	0.42	117	53.33	0.41	57	77.52	0.39				23	108.96	0.39	83	132.04	0.38
176	28.78	0.43	116	53.74	0.41	56	77.92	0.40				24	109.35	0.39	84	132.42	0.38
175	29.20	0.42	115	54.15	0.41	55	78.32	0.40				25	109.73	0.38	85	132.80	0.38
174	29.63	0.43	114	54.56	0.41	54	78.72	0.40				26	110.12	0.39	86	133.18	0.38
173	30.05	0.42	113	54.97	0.41	53	79.11	0.39				27	110.51	0.39	87	133.56	0.38
172	30.47	0.42	112	55.38	0.41	52	79.51	0.40				28	110.90	0.39	88	133.94	0.38
171	30.90	0.43	111	55.78	0.40	51	79.91	0.40				29	111.28	0.38	89	134.32	0.38
170	31.32	0.42	110	56.19	0.41	50	80.31	0.40				30	111.67	0.39	90	134.70	0.38
169	31.74	0.42	109	56.60	0.41	49	80.70	0.39				31	112.06	0.39	91	135.08	0.38
168	32.16	0.42	108	57.00	0.40	48	81.10	0.40				32	112.45	0.39	92	135.46	0.38
167	32.59	0.43	107	57.41	0.41	47	81.50	0.40				33	112.83	0.38	93	135.84	0.38
166	33.01	0.42	106	57.82	0.41	46	81.89	0.39				34	113.22	0.39	94	136.22	0.38
165	33.43	0.42	105	58.22	0.40	45	82.29	0.40				35	113.61	0.39	95	136.60	0.38
164	33.85	0.42	104	58.63	0.41	44	82.69	0.40				36	113.99	0.38	96	136.98	0.38
163	34.27	0.42	103	59.04	0.41	43	83.08	0.39				37	114.38	0.39	97	137.36	0.38
162	34.69	0.42	102	59.44	0.40	42	83.48	0.40				38	114.77	0.39	98	137.74	0.38
161	35.11	0.42	101	59.85	0.41	41	83.88	0.40				39	115.15	0.38	99	138.12	0.38
160	35.53	0.42	100	60.25	0.40	40	84.27	0.39				40	115.54	0.39	100	138.50	0.38
159	35.95	0.42	99	60.66	0.41	39	84.67	0.40				41	115.93	0.39	101	138.88	0.38
158	36.37	0.42	98	61.06	0.40	38	85.06	0.39				42	116.31	0.38	102	139.26	0.38
157	36.79	0.42	97	61.47	0.41	37	85.46	0.40				43	116.70	0.39	103	139.64	0.38
156	37.21	0.42	96	61.87	0.40	36	85.85	0.39				44	117.08	0.38	104	140.02	0.38
155	37.63	0.42	95	62.28	0.41	35	86.25	0.40				45	117.47	0.39	105	140.39	0.37
154	38.04	0.41	94	62.68	0.40	34	86.64	0.39				46	117.85	0.38	106	140.77	0.38
153	38.46	0.42	93	63.09	0.41	33	87.04	0.40				47	118.24	0.39	107	141.15	0.38
152	38.88	0.42	92	63.49	0.40	32	87.43	0.39				48	118.62	0.38	108	141.53	0.38
151	39.30	0.42	91	63.90	0.41	31	87.83	0.40				49	119.01	0.39	109	141.91	0.38
150	39.71	0.41	90	64.30	0.40	30	88.22	0.39				50	119.40	0.39	110	142.29	0.38
149	40.13	0.42	89	64.70	0.40	29	88.62	0.40				51	119.78	0.38	111	142.66	0.37
148	40.55	0.42	88	65.11	0.41	28	89.01	0.39				52	120.16	0.38	112	143.04	0.38
147	40.96	0.41	87	65.51	0.40	27	89.40	0.39				53	120.55	0.39	113	143.42	0.38
146	41.38	0.42	86	65.91	0.40	26	89.80	0.40				54	120.93	0.38	114	143.80	0.38
145	41.79	0.41	85	66.31	0.40	25	90.19	0.39				55	121.32	0.39	115	144.17	0.37
144	42.21	0.42	84	66.72	0.41	24	90.59	0.40				56	121.70	0.38	116	144.55	0.38
143	42.63	0.42	83	67.12	0.40	23	90.98	0.39				57	122.09	0.39	117	144.93	0.38
142	43.04	0.41	82	67.52	0.40	22	91.37	0.39				58	122.47	0.38	118	145.31	0.38
141	43.45	0.41	81	67.92	0.40	21	91.77	0.40				59	122.86	0.39	119	145.68	0.37

Note: At 100°C resistance is 138.50 ohms.

(DIN 43 760)

TABLE XVIII (con't.) Temperature Vs. Resistance Table

For European Curve, Alpha = .00385

1° Celsius Increments

°C	Ohm	Diff.	°C	Ohm	Diff.	°C	Ohm	Diff.	°C	Ohm	Diff.	°C	Ohm	Diff.	°C	Ohm	Diff.
+120	146.06	0.38	**+180**	168.46	0.37	**+240**	190.45	0.36	**+300**	212.02	0.36	**+360**	233.17	0.35	**+420**	253.90	0.34
121	146.44	0.38	**181**	168.83	0.37	**241**	190.81	0.36	**301**	212.37	0.35	**361**	233.52	0.35	**421**	254.24	0.34
122	146.81	0.37	**182**	169.20	0.37	**242**	191.18	0.37	**302**	212.73	0.36	**362**	233.87	0.35	**422**	254.59	0.35
123	147.19	0.38	**183**	169.57	0.37	**243**	191.54	0.36	**303**	213.09	0.36	**363**	234.22	0.35	**423**	254.93	0.34
124	147.57	0.38	**184**	169.94	0.37	**244**	191.90	0.36	**304**	213.44	0.35	**364**	234.56	0.34	**424**	255.27	0.34
125	147.94	0.37	**185**	170.31	0.37	**245**	192.26	0.36	**305**	213.80	0.36	**365**	234.91	0.35	**425**	255.61	0.34
126	148.32	0.38	**186**	170.68	0.37	**246**	192.63	0.37	**306**	214.15	0.35	**366**	235.26	0.35	**426**	255.95	0.34
127	148.70	0.38	**187**	171.05	0.37	**247**	192.99	0.36	**307**	214.51	0.36	**367**	235.61	0.35	**427**	256.29	0.34
128	149.07	0.37	**188**	171.42	0.37	**248**	193.35	0.36	**308**	214.86	0.35	**368**	235.96	0.35	**428**	256.64	0.35
129	149.45	0.38	**189**	171.79	0.37	**249**	193.71	0.36	**309**	215.22	0.36	**369**	236.31	0.35	**429**	256.98	0.34
130	149.82	0.37	**190**	172.16	0.37	**250**	194.07	0.36	**310**	215.57	0.35	**370**	236.65	0.34	**430**	257.32	0.34
131	150.20	0.38	**191**	172.53	0.37	**251**	194.44	0.37	**311**	215.93	0.36	**371**	237.00	0.35	**431**	257.66	0.34
132	150.57	0.37	**192**	172.90	0.37	**252**	194.80	0.36	**312**	216.28	0.35	**372**	237.35	0.35	**432**	258.00	0.34
133	150.95	0.38	**193**	173.26	0.36	**253**	195.16	0.36	**313**	216.64	0.36	**373**	237.70	0.35	**433**	258.34	0.34
134	151.33	0.38	**194**	173.63	0.37	**254**	195.52	0.36	**314**	216.99	0.35	**374**	238.04	0.34	**434**	258.68	0.34
135	151.70	0.37	**195**	174.00	0.37	**255**	195.88	0.36	**315**	217.35	0.36	**375**	238.39	0.35	**435**	259.02	0.34
136	152.08	0.38	**196**	174.37	0.37	**256**	196.24	0.36	**316**	217.70	0.35	**376**	238.74	0.35	**436**	259.36	0.34
137	152.45	0.37	**197**	174.74	0.37	**257**	196.60	0.36	**317**	218.05	0.35	**377**	239.09	0.35	**437**	259.70	0.34
138	152.83	0.38	**198**	175.10	0.36	**258**	196.96	0.36	**318**	218.41	0.36	**378**	239.43	0.34	**438**	260.04	0.34
139	153.20	0.37	**199**	175.47	0.37	**259**	197.33	0.37	**319**	218.76	0.35	**379**	239.78	0.35	**439**	260.38	0.34
140	153.58	0.38	**200**	175.84	0.37	**260**	197.69	0.36	**320**	219.12	0.36	**380**	240.13	0.35	**440**	260.72	0.34
141	153.95	0.37	**201**	176.21	0.37	**261**	198.05	0.36	**321**	219.47	0.35	**381**	240.47	0.34	**441**	261.06	0.34
142	154.32	0.37	**202**	176.57	0.36	**262**	198.41	0.36	**322**	219.82	0.35	**382**	240.82	0.35	**442**	261.40	0.34
143	154.70	0.38	**203**	176.94	0.37	**263**	198.77	0.36	**323**	220.18	0.36	**383**	241.17	0.35	**443**	261.74	0.34
144	155.07	0.37	**204**	177.31	0.37	**264**	199.13	0.36	**324**	220.53	0.35	**384**	241.51	0.34	**444**	262.08	0.34
145	155.45	0.38	**205**	177.68	0.37	**265**	199.49	0.36	**325**	220.88	0.35	**385**	241.86	0.35	**445**	262.42	0.34
146	155.82	0.37	**206**	178.04	0.36	**266**	199.85	0.36	**326**	221.24	0.36	**386**	242.20	0.34	**446**	262.76	0.34
147	156.19	0.37	**207**	178.41	0.37	**267**	200.21	0.36	**327**	221.59	0.35	**387**	242.55	0.35	**447**	263.10	0.34
148	156.57	0.38	**208**	178.78	0.37	**268**	200.57	0.36	**328**	221.94	0.35	**388**	242.90	0.35	**448**	263.43	0.33
149	156.94	0.37	**209**	179.14	0.36	**269**	200.93	0.36	**329**	222.29	0.35	**389**	243.24	0.34	**449**	263.77	0.34
150	157.31	0.37	**210**	179.51	0.37	**270**	201.29	0.36	**330**	222.65	0.36	**390**	243.59	0.35	**450**	264.11	0.34
151	157.69	0.38	**211**	179.88	0.37	**271**	201.65	0.36	**331**	223.00	0.35	**391**	243.93	0.34	**451**	264.45	0.34
152	158.06	0.37	**212**	180.24	0.36	**272**	202.01	0.36	**332**	223.35	0.35	**392**	244.28	0.35	**452**	264.79	0.34
153	158.43	0.37	**213**	180.61	0.37	**273**	202.36	0.35	**333**	223.70	0.35	**393**	244.62	0.34	**453**	265.13	0.34
154	158.81	0.38	**214**	180.97	0.36	**274**	202.72	0.36	**334**	224.06	0.36	**394**	244.97	0.35	**454**	265.47	0.34
155	159.18	0.37	**215**	181.34	0.37	**275**	203.08	0.36	**335**	224.41	0.35	**395**	245.31	0.34	**455**	265.80	0.33
156	159.55	0.37	**216**	181.71	0.37	**276**	203.44	0.36	**336**	224.76	0.35	**396**	245.66	0.35	**456**	266.14	0.34
157	159.93	0.38	**217**	182.07	0.36	**277**	203.80	0.36	**337**	225.11	0.35	**397**	246.00	0.34	**457**	266.48	0.34
158	160.30	0.37	**218**	182.44	0.37	**278**	204.16	0.36	**338**	225.46	0.35	**398**	246.35	0.35	**458**	266.82	0.34
159	160.67	0.37	**219**	182.80	0.36	**279**	204.52	0.36	**339**	225.81	0.35	**399**	246.69	0.34	**459**	267.15	0.33
160	161.04	0.37	**220**	183.17	0.37	**280**	204.88	0.36	**340**	226.17	0.36	**400**	247.04	0.35	**460**	267.49	0.34
161	161.42	0.38	**221**	183.53	0.36	**281**	205.23	0.35	**341**	226.52	0.35	**401**	247.38	0.34	**461**	267.83	0.34
162	161.79	0.37	**222**	183.90	0.37	**282**	205.59	0.36	**342**	226.87	0.35	**402**	247.73	0.35	**462**	268.17	0.34
163	162.16	0.37	**223**	184.26	0.36	**283**	205.95	0.36	**343**	227.22	0.35	**403**	248.07	0.34	**463**	268.50	0.33
164	162.53	0.37	**224**	184.63	0.37	**284**	206.31	0.36	**344**	227.57	0.35	**404**	248.41	0.34	**464**	268.84	0.34
165	162.90	0.37	**225**	184.99	0.36	**285**	206.67	0.36	**345**	227.92	0.35	**405**	248.76	0.35	**465**	269.18	0.34
166	163.27	0.37	**226**	185.36	0.37	**286**	207.02	0.35	**346**	228.27	0.35	**406**	249.10	0.34	**466**	269.51	0.33
167	163.65	0.38	**227**	185.72	0.36	**287**	207.38	0.36	**347**	228.62	0.35	**407**	249.45	0.35	**467**	269.85	0.34
168	164.02	0.37	**228**	186.09	0.37	**288**	207.74	0.36	**348**	228.97	0.35	**408**	249.79	0.34	**468**	270.19	0.34
169	164.39	0.37	**229**	186.45	0.36	**289**	208.10	0.36	**349**	229.32	0.35	**409**	250.13	0.34	**469**	270.52	0.33
170	164.76	0.37	**230**	186.82	0.37	**290**	208.45	0.35	**350**	229.67	0.35	**410**	250.48	0.35	**470**	270.86	0.34
171	165.13	0.37	**231**	187.18	0.36	**291**	208.81	0.36	**351**	230.02	0.35	**411**	250.82	0.34	**471**	271.20	0.34
172	165.50	0.37	**232**	187.54	0.36	**292**	209.17	0.36	**352**	230.37	0.35	**412**	251.16	0.34	**472**	271.53	0.33
173	165.87	0.37	**233**	187.91	0.37	**293**	209.52	0.35	**353**	230.72	0.35	**413**	251.50	0.34	**473**	271.87	0.34
174	166.24	0.37	**234**	188.27	0.36	**294**	209.88	0.36	**354**	231.07	0.35	**414**	251.85	0.35	**474**	272.20	0.33
175	166.61	0.37	**235**	188.63	0.36	**295**	210.24	0.36	**355**	231.42	0.35	**415**	252.19	0.34	**475**	272.54	0.34
176	166.98	0.37	**236**	189.00	0.37	**296**	210.59	0.35	**356**	231.77	0.35	**416**	252.53	0.34	**476**	272.88	0.34
177	167.35	0.37	**237**	189.36	0.36	**297**	210.95	0.36	**357**	232.12	0.35	**417**	252.88	0.35	**477**	273.21	0.33
178	167.72	0.37	**238**	189.72	0.36	**298**	211.31	0.36	**358**	232.47	0.35	**418**	253.22	0.34	**478**	273.55	0.34
179	168.09	0.37	**239**	190.09	0.37	**299**	211.66	0.35	**359**	232.82	0.35	**419**	253.56	0.34	**479**	273.88	0.33

Note: At 100°C resistance is 138.50 ohms.

(DIN 43 760)

TABLE XVIII (Con't.) Temperature Vs. Resistance Table

For European Curve, Alpha = .00385

1° Celsius Increments

°C	Ohm	Diff.	°C	Ohm	Diff.	°C	Ohm	Diff.	°C	Ohm	Diff.	°C	Ohm	Diff.	°C	Ohm	Diff.
+480	274.22	0.34	**+542**	294.77	0.33	**+604**	314.88	0.32	**+666**	334.54	0.31	**+728**	353.75	0.30	**+790**	372.52	0.30
481	274.55	0.33	**543**	295.10	0.33	**605**	315.20	0.32	**667**	334.85	0.31	**729**	354.06	0.31	**791**	372.82	0.30
482	274.89	0.34	**544**	295.43	0.33	**606**	315.52	0.32	**668**	335.17	0.32	**730**	354.37	0.31	**792**	373.12	0.30
483	275.22	0.33	**545**	295.75	0.32	**607**	315.84	0.32	**669**	335.48	0.31	**731**	354.67	0.30	**793**	373.42	0.30
484	275.56	0.34	**546**	296.08	0.33	**608**	316.16	0.32	**670**	335.79	0.31	**732**	354.98	0.31	**794**	373.72	0.30
485	275.89	0.33	**547**	296.41	0.33	**609**	316.48	0.32	**671**	336.11	0.32	**733**	355.28	0.30	**795**	374.02	0.30
486	276.23	0.34	**548**	296.74	0.33	**610**	316.80	0.32	**672**	336.42	0.31	**734**	355.59	0.31	**796**	374.32	0.30
487	276.56	0.33	**549**	297.06	0.32	**611**	317.12	0.32	**673**	336.73	0.31	**735**	355.90	0.31	**797**	374.61	0.29
488	276.89	0.33	**550**	297.39	0.33	**612**	317.44	0.32	**674**	337.04	0.31	**736**	356.20	0.30	**798**	374.91	0.30
489	277.23	0.34	**551**	297.72	0.33	**613**	317.76	0.32	**675**	337.36	0.32	**737**	356.51	0.31	**799**	375.21	0.30
490	277.56	0.33	**552**	298.04	0.32	**614**	318.08	0.32	**676**	337.67	0.31	**738**	356.81	0.30	**800**	375.51	0.30
491	277.90	0.34	**553**	298.37	0.33	**615**	318.40	0.32	**677**	337.98	0.31	**739**	357.12	0.31	**801**	375.81	0.30
492	278.23	0.33	**554**	298.70	0.33	**616**	318.72	0.32	**678**	338.29	0.31	**740**	357.42	0.30	**802**	376.10	0.29
493	278.56	0.33	**555**	299.02	0.32	**617**	319.04	0.32	**679**	338.61	0.32	**741**	357.73	0.31	**803**	376.40	0.30
494	278.90	0.34	**556**	299.35	0.33	**618**	319.36	0.32	**680**	338.92	0.31	**742**	358.03	0.30	**804**	376.70	0.30
495	279.23	0.33	**557**	299.68	0.33	**619**	319.68	0.32	**681**	339.23	0.31	**743**	358.34	0.31	**805**	377.00	0.30
496	279.56	0.33	**558**	300.00	0.32	**620**	319.99	0.31	**682**	339.54	0.31	**744**	358.64	0.30	**806**	377.29	0.29
497	279.90	0.34	**559**	300.33	0.33	**621**	320.31	0.32	**683**	339.85	0.31	**745**	358.95	0.31	**807**	377.59	0.30
498	280.23	0.33	**560**	300.65	0.32	**622**	320.63	0.32	**684**	340.16	0.31	**746**	359.25	0.30	**808**	377.89	0.30
499	280.56	0.33	**561**	300.98	0.33	**623**	320.95	0.32	**685**	340.48	0.32	**747**	359.55	0.30	**809**	378.19	0.30
500	280.90	0.34	**562**	301.31	0.33	**624**	321.27	0.32	**686**	340.79	0.31	**748**	359.86	0.31	**810**	378.48	0.29
501	281.23	0.33	**563**	301.63	0.32	**625**	321.59	0.32	**687**	341.10	0.31	**749**	360.16	0.30	**811**	378.78	0.30
502	281.56	0.33	**564**	301.96	0.33	**626**	321.91	0.32	**688**	341.41	0.31	**750**	360.47	0.31	**812**	379.08	0.30
503	281.89	0.33	**565**	302.28	0.32	**627**	322.22	0.31	**689**	341.72	0.31	**751**	360.77	0.30	**813**	379.37	0.29
504	282.23	0.34	**566**	302.61	0.33	**628**	322.54	0.32	**690**	342.03	0.31	**752**	361.07	0.30	**814**	379.67	0.30
505	282.56	0.33	**567**	302.93	0.32	**629**	322.86	0.32	**691**	342.34	0.31	**753**	361.38	0.31	**815**	379.97	0.30
506	282.89	0.33	**568**	303.26	0.33	**630**	323.18	0.32	**692**	342.65	0.31	**754**	361.68	0.30	**816**	380.26	0.29
507	283.22	0.33	**569**	303.58	0.32	**631**	323.49	0.31	**693**	342.96	0.31	**755**	361.98	0.30	**817**	380.56	0.30
508	283.55	0.33	**570**	303.91	0.33	**632**	323.81	0.32	**694**	343.27	0.31	**756**	362.29	0.31	**818**	380.85	0.29
509	283.89	0.34	**571**	304.23	0.32	**633**	324.13	0.32	**695**	343.58	0.31	**757**	362.59	0.30	**819**	381.15	0.30
510	284.22	0.33	**572**	304.56	0.33	**634**	324.45	0.32	**696**	343.89	0.31	**758**	362.89	0.30	**820**	381.45	0.30
511	284.55	0.33	**573**	304.88	0.32	**635**	324.76	0.31	**697**	344.20	0.31	**759**	363.19	0.30	**821**	381.74	0.29
512	284.88	0.33	**574**	305.20	0.32	**636**	325.08	0.32	**698**	344.51	0.31	**760**	363.50	0.31	**822**	382.04	0.30
513	285.21	0.33	**575**	305.53	0.33	**637**	325.40	0.32	**699**	344.82	0.31	**761**	363.80	0.30	**823**	382.33	0.29
514	285.54	0.33	**576**	305.85	0.32	**638**	325.72	0.32	**700**	345.13	0.31	**762**	364.10	0.30	**824**	382.63	0.30
515	285.87	0.33	**577**	306.18	0.33	**639**	326.03	0.31	**701**	345.44	0.31	**763**	364.40	0.30	**825**	382.92	0.29
516	286.21	0.34	**578**	306.50	0.32	**640**	326.35	0.32	**702**	345.75	0.31	**764**	364.71	0.31	**826**	383.22	0.30
517	286.54	0.33	**579**	306.82	0.32	**641**	326.66	0.31	**703**	346.06	0.31	**765**	365.01	0.30	**827**	383.51	0.29
518	286.87	0.33	**580**	307.15	0.33	**642**	326.98	0.32	**704**	346.37	0.31	**766**	365.31	0.30	**828**	383.81	0.30
519	287.20	0.33	**581**	307.47	0.32	**643**	327.30	0.32	**705**	346.68	0.31	**767**	365.61	0.30	**829**	384.10	0.29
520	287.53	0.33	**582**	307.79	0.32	**644**	327.61	0.31	**706**	346.99	0.31	**768**	365.91	0.30	**830**	384.40	0.30
521	287.86	0.33	**583**	308.12	0.33	**645**	327.93	0.32	**707**	347.30	0.31	**769**	366.22	0.31	**831**	384.69	0.29
522	288.19	0.33	**584**	308.44	0.32	**646**	328.25	0.32	**708**	347.60	0.30	**770**	366.52	0.30	**832**	384.98	0.29
523	288.52	0.33	**585**	308.76	0.32	**647**	328.56	0.31	**709**	347.91	0.31	**771**	366.82	0.30	**833**	385.28	0.30
524	288.85	0.33	**586**	309.09	0.33	**648**	328.88	0.32	**710**	348.22	0.31	**772**	367.12	0.30	**834**	385.57	0.29
525	289.18	0.33	**587**	309.41	0.32	**649**	329.19	0.31	**711**	348.53	0.31	**773**	367.42	0.30	**835**	385.87	0.30
526	289.51	0.33	**588**	309.73	0.32	**650**	329.51	0.32	**712**	348.84	0.31	**774**	367.72	0.30	**836**	386.16	0.29
527	289.84	0.33	**589**	310.05	0.32	**651**	329.82	0.31	**713**	349.15	0.31	**775**	368.02	0.30	**837**	386.45	0.29
528	290.17	0.33	**590**	310.38	0.33	**652**	330.14	0.32	**714**	349.45	0.30	**776**	368.32	0.30	**838**	386.75	0.30
529	290.50	0.33	**591**	310.70	0.32	**653**	330.45	0.31	**715**	349.76	0.31	**777**	368.63	0.31	**839**	387.04	0.29
530	290.83	0.33	**592**	311.02	0.32	**654**	330.77	0.32	**716**	350.07	0.31	**778**	368.93	0.30	**840**	387.34	0.30
531	291.16	0.33	**593**	311.34	0.32	**655**	331.08	0.31	**717**	350.38	0.31	**779**	369.23	0.30	**841**	387.63	0.29
532	291.49	0.33	**594**	311.67	0.33	**656**	331.40	0.32	**718**	350.69	0.31	**780**	369.53	0.30	**842**	387.92	0.29
533	291.81	0.32	**595**	311.99	0.32	**657**	331.71	0.31	**719**	350.99	0.30	**781**	369.83	0.30	**843**	388.21	0.29
534	292.14	0.33	**596**	312.31	0.32	**658**	332.03	0.32	**720**	351.30	0.31	**782**	370.13	0.30	**844**	388.51	0.30
535	292.47	0.33	**597**	312.63	0.32	**659**	332.34	0.31	**721**	351.61	0.31	**783**	370.43	0.30	**845**	388.80	0.29
536	292.80	0.33	**598**	312.95	0.32	**660**	332.66	0.32	**722**	351.91	0.30	**784**	370.73	0.30	**846**	389.09	0.29
537	293.13	0.33	**599**	313.27	0.32	**661**	332.97	0.31	**723**	352.22	0.31	**785**	371.03	0.30	**847**	389.39	0.30
538	293.46	0.33	**600**	313.59	0.32	**662**	333.28	0.31	**724**	352.53	0.31	**786**	371.33	0.30	**848**	389.68	0.29
539	293.79	0.33	**601**	313.92	0.33	**663**	333.60	0.32	**725**	352.83	0.30	**787**	371.63	0.30	**849**	389.97	0.29
540	294.11	0.32	**602**	314.24	0.32	**664**	333.91	0.31	**726**	353.14	0.31	**788**	371.93	0.30	**850**	390.26	0.29
541	294.44	0.33	**603**	314.56	0.32	**665**	334.23	0.32	**727**	353.45	0.31	**789**	372.22	0.29			

Note: At 100°C resistance is 138.50 ohms.

(DIN 43 760)

Temperature vs. Resistance Table

RT/RO Value of Standard Resistance Element

Platinum Resistance Element – Ro = 100 Ohms

For Alpha (α) = 0.00392

Temp. °C	Rt/Ro	Temp. °C	Rt/Ro	Temp. °C	Rt/Ro	Temp. °C	Rt/Ro
–200	0.1714	10	1.0397	220	1.8158	430	2.6002
–190	0.2146	20	1.0793	230	1.8829	440	2.6348
–180	0.2580	30	1.1188	240	1.9199	450	2.6694
–170	0.3012	40	1.1581	250	1.9567	460	2.7038
–160	0.3442	50	1.1973	260	1.9935	470	2.7380
–150	0.3868	60	1.2364	270	2.0301	480	2.7722
–140	0.4291	70	1.2754	280	2.0666	490	2.8063
–130	0.4711	80	1.3142	290	2.1030	500	2.8402
–120	0.5129	90	1.3530	300	2.1393	510	2.8740
–110	0.5544	100	1.3916	310	2.1754	520	2.9077
–100	0.5957	110	1.4301	320	2.2115	530	2.9412
– 90	0.6368	120	1.4685	330	2.2474	540	2.9747
– 80	0.6777	130	1.5067	340	2.2832	550	3.0080
– 70	0.7185	140	1.5449	350	2.3189	560	3.0412
– 60	0.7591	150	1.5829	360	2.3545	570	3.0743
– 50	0.7996	160	1.6208	370	2.3899	580	3.1072
– 40	0.8399	170	1.6586	380	2.4253	590	3.1401
– 30	0.8801	180	1.6963	390	2.4605	600	3.1728
– 20	0.9202	190	1.7338	400	2.4956	(610	3.2054)
– 10	0.9602	200	1.7713	410	2.5306	(620	3.2378)
0	1.0000	210	1.8086	420	2.5655	(630	3.2702)

"INTERCHANGEABILITY TABLE"

PLATINUM RESISTANCE TEMPERATURE DETECTORS

0°C	±0.20°C
200 to 300°C	±0.35°C

TABLE XX Thermistor Resistance Versus Temperature

PART NO.	44004 44033	44005 44030	44007 44034	44006 44031	44008 44032
Ω@25°C	2252	3000	5000	10,000	30,000
BODY	BLACK ORANGE	BLACK ORANGE	BLACK ORANGE	BLACK ORANGE	BLACK ORANGE
END	YELLOW ORANGE	GREEN BLACK	VIOLET YELLOW	BLUE BROWN	GRAY RED
TEMP. °C	RESISTANCE Ω				
—80	1660K	2211K	3685K	3558K	
79	1518K	2022K	3371K	3296K	
78	1390K	1851K	3086K	3055K	
77	1273K	1696K	2827K	2833K	
76	1167K	1555K	2592K	2629K	
75	1071K	1426K	2378K	2440K	
74	982.8K	1309K	2182K	2266K	
73	902.7K	1202K	2005K	2106K	
72	829.7K	1105K	1843K	1957K	
71	763.1K	1016K	1695K	1821K	
—70	702.3K	935.4K	1560K	1694K	
69	646.7K	861.4K	1436K	1577K	
68	595.9K	793.7K	1323K	1469K	
67	549.4K	731.8K	1220K	1369K	
66	506.9K	675.2K	1126K	1276K	
65	467.9K	623.3K	1039K	1190K	
64	432.2K	575.7K	959.9K	1111K	
63	399.5K	532.1K	887.2K	1037K	
62	369.4K	492.1K	820.5K	968.4K	
61	341.8K	455.3K	759.2K	904.9K	
—60	316.5K	421.5K	702.9K	845.9K	
59	293.2K	390.5K	651.1K	791.1K	
58	271.7K	361.9K	603.5K	740.2K	
57	252.0K	335.7K	559.7K	692.8K	
56	233.8K	311.5K	519.4K	648.8K	
55	217.1K	289.2K	482.2K	607.8K	
54	201.7K	268.6K	447.9K	569.6K	
53	187.4K	249.7K	416.3K	534.1K	
52	174.3K	232.2K	387.1K	501.0K	
51	162.2K	216.0K	360.2K	470.1K	
—50	151.0K	201.1K	335.3K	441.3K	
49	140.6K	187.3K	312.3K	414.5K	
48	131.0K	174.5K	291.0K	389.4K	
47	122.1K	162.7K	271.3K	366.0K	
46	113.9K	151.7K	253.0K	344.1K	
45	106.3K	141.6K	236.2K	323.7K	
44	99.26K	132.2K	220.5K	304.6K	
43	92.72K	123.5K	205.9K	286.7K	
42	86.65K	115.4K	192.5K	270.0K	
41	81.02K	107.9K	180.0K	254.4K	
—40	75.79K	101.0K	168.3K	239.8K	884.6K
39	70.93K	94.48K	157.5K	226.0K	830.9K
38	66.41K	88.46K	147.5K	213.2K	780.8K
37	62.21K	82.87K	138.2K	201.1K	733.9K
36	58.30K	77.66K	129.5K	189.8K	690.2K
35	54.66K	72.81K	121.4K	179.2K	649.3K
34	51.27K	68.30K	113.9K	169.3K	611.0K
33	48.11K	64.09K	106.9K	160.0K	575.2K
32	45.17K	60.17K	100.3K	151.2K	541.7K
31	42.42K	56.51K	94.22K	143.0K	510.4K
—30	39.86K	53.10K	88.53K	135.2K	481.0K
29	37.47K	49.91K	83.22K	127.9K	453.5K
28	35.24K	46.94K	78.26K	121.1K	427.7K
27	33.15K	44.16K	73.62K	114.6K	403.5K
26	31.20K	41.56K	69.29K	108.6K	380.9K
25	29.38K	39.13K	65.24K	102.9K	359.6K
24	27.67K	36.86K	61.45K	97.49K	339.6K
23	26.07K	34.73K	57.90K	92.43K	320.9K
22	24.58K	32.74K	54.58K	87.66K	303.3K
21	23.18K	30.87K	51.47K	83.16K	286.7K
—20	21.87K	29.13K	48.56K	78.91K	271.2K
19	20.64K	27.49K	45.83K	74.91K	256.5K
18	19.48K	25.95K	43.27K	71.13K	242.8K
17	18.40K	24.51K	40.86K	67.57K	229.8K
16	17.39K	23.16K	38.61K	64.20K	217.6K
15	16.43K	21.89K	36.49K	61.02K	206.2K
14	15.54K	20.70K	34.50K	58.01K	195.4K
13	14.70K	19.58K	32.63K	55.17K	185.2K
12	13.91K	18.52K	30.88K	52.48K	175.6K
11	13.16K	17.53K	29.23K	49.94K	166.6K
—10	12.46K	16.60K	27.67K	47.54K	158.0K
9	11.81K	15.72K	26.21K	45.27K	150.0K
8	11.19K	14.90K	24.83K	43.11K	142.4K
7	10.60K	14.12K	23.54K	41.07K	135.2K
6	10.05K	13.39K	22.32K	39.14K	128.5K
5	9534	12.70K	21.17K	37.31K	122.1K
4	9046	12.05K	20.08K	35.57K	116.0K
3	8586	11.44K	19.06K	33.93K	110.3K
2	8151	10.86K	18.10K	32.37K	104.9K
— 1	7741	10.31K	17.19K	30.89K	99.80K
0	7355	9796	16.33K	29.49K	94.98K
+ 1	6989	9310	15.52K	28.15K	90.41K
2	6644	8851	14.75K	26.89K	86.09K
3	6319	8417	14.03K	25.69K	81.99K
4	6011	8006	13.34K	24.55K	78.11K
5	5719	7618	12.70K	23.46K	74.44K
6	5444	7252	12.09K	22.43K	70.96K
7	5183	6905	11.51K	21.45K	67.66K
8	4937	6576	10.96K	20.52K	64.53K
9	4703	6265	10.44K	19.63K	61.56K
+10	4482	5971	9951	18.79K	58.75K
11	4273	5692	9486	17.98K	56.07K
12	4074	5427	9046	17.22K	53.54K
13	3886	5177	8628	16.49K	51.13K
14	3708	4939	8232	15.79K	48.84K
15	3539	4714	7857	15.13K	46.67K
16	3378	4500	7500	14.50K	44.60K
17	3226	4297	7162	13.90K	42.64K
18	3081	4105	6841	13.33K	40.77K
19	2944	3922	6536	12.79K	38.99K
+20	2814	3748	6247	12.26K	37.30K
21	2690	3583	5972	11.77K	35.70K
22	2572	3426	5710	11.29K	34.17K
23	2460	3277	5462	10.84K	32.71K
24	2354	3135	5225	10.41K	31.32K
25	2252	3000	5000	10.00K	30.00K
26	2156	2872	4787	9605	28.74K
27	2064	2750	4583	9227	27.54K
28	1977	2633	4389	8867	26.40K
29	1894	2523	4204	8523	25.31K
+30	1815	2417	4029	8194	24.27K
31	1739	2317	3861	7880	23.28K
32	1667	2221	3702	7579	22.33K
33	1599	2130	3549	7291	21.43K
34	1533	2042	3404	7016	20.57K
35	1471	1959	3266	6752	19.74K
36	1412	1880	3134	6500	18.96K
37	1355	1805	3008	6258	18.21K
38	1301	1733	2888	6026	17.49K
+39	1249	1664	2773	5805	16.80K

Note: Data in black refer to thermistors with ±0.2°C interchangeability. Data in brown refer to thermistors with ±0.1°C interchangeability. Temperature/resistance figures are the same for both types.

Note: Only thermistors with ±0.2°C interchangeability are available encased in Teflon as standard parts. For Part No. of Teflon encased thermistors add 100 to part No. of ±0.2°C interchangeable thermistors. Example: 44005 is a standard thermistor, 44105 is a Teflon encased thermistor with the same resistance values.

Table XX

Thermistor Resistance Versus Temperature

PART NO.	44004 44033	44005 44030	44007 44034	44006 44031	44008 44032
Ω@25°C	2252	3000	5000	10,000	30,000
BODY	BLACK ORANGE	BLACK ORANGE	BLACK ORANGE	BLACK ORANGE	BLACK ORANGE
END	YELLOW ORANGE	GREEN BLACK	VIOLET YELLOW	BLUE BROWN	GRAY RED
TEMP. °C	RESISTANCE Ω				
+40	1200	1598	2663	5592	16.15K
41	1152	1535	2559	5389	15.52K
42	1107	1475	2459	5193	14.92K
43	1064	1418	2363	5006	14.35K
44	1023	1363	2272	4827	13.80K
45	983.8	1310	2184	4655	13.28K
46	946.2	1260	2101	4489	12.77K
47	910.2	1212	2021	4331	12.29K
48	875.8	1167	1944	4179	11.83K
49	842.8	1123	1871	4033	11.39K
+50	811.3	1081	1801	3893	10.97K
51	781.1	1040	1734	3758	10.57K
52	752.2	1002	1670	3629	10.18K
53	724.5	965.0	1608	3504	9807
54	697.9	929.6	1549	3385	9450
55	672.5	895.8	1493	3270	9109
56	648.1	863.3	1439	3160	8781
57	624.8	832.2	1387	3054	8467
58	602.4	802.3	1337	2952	8166
59	580.9	773.7	1290	2854	7876
+60	560.3	746.3	1244	2760	7599
61	540.5	719.9	1200	2669	7332
62	521.5	694.7	1158	2582	7076
63	503.3	670.4	1117	2497	6830
64	485.8	647.1	1079	2417	6594
65	469.0	624.7	1041	2339	6367
66	452.9	603.3	1006	2264	6149
67	437.4	582.6	971.1	2191	5940
68	422.5	562.8	938.0	2122	5738
69	408.2	543.7	906.3	2055	5545
+70	394.5	525.4	875.7	1990	5359
71	381.2	507.8	846.4	1928	5180
72	368.5	490.9	818.3	1868	5007
73	356.2	474.7	791.2	1810	4842
74	344.5	459.0	765.1	1754	4682
75	333.1	444.0	740.0	1700	4529
76	322.3	429.5	715.9	1648	4381
77	311.8	415.6	692.7	1598	4239
78	301.7	402.2	670.3	1549	4102
79	292.0	389.3	648.8	1503	3970
+80	282.7	376.9	628.1	1458	3843
81	273.7	364.9	608.2	1414	3720
82	265.0	353.4	588.9	1372	3602
83	256.7	342.2	570.4	1332	3489
84	248.6	331.5	552.6	1293	3379
85	240.9	321.2	535.4	1255	3273
86	233.4	311.3	518.8	1218	3172
87	226.2	301.7	502.8	1183	3073
88	219.3	292.4	487.4	1149	2979
89	212.6	283.5	472.6	1116	2887
+90	206.1	274.9	458.2	1084	2799
91	199.9	266.6	444.4	1053	2714
92	193.9	258.6	431.0	1023	2632
93	188.1	250.9	418.2	994.2	2552
94	182.5	243.4	405.7	966.3	2476
95	177.1	236.2	393.7	939.3	2402
96	171.9	229.3	382.1	913.2	2331
97	166.9	222.6	370.9	887.9	2262
98	162.0	216.1	360.1	863.4	2195
99	157.3	209.8	349.7	839.7	2131

PART NO.	44004 44033	44005 44030	44007 44034	44006 44031	44008 44032
Ω@25°C	2252	3000	5000	10,000	30,000
BODY	BLACK ORANGE	BLACK ORANGE	BLACK ORANGE	BLACK ORANGE	BLACK ORANGE
END	YELLOW ORANGE	GREEN BLACK	VIOLET YELLOW	BLUE BROWN	GRAY RED
TEMP. °C	RESISTANCE Ω				
+100	152.8	203.8	339.6	816.8	2069
101	148.4	197.9	329.8	794.6	2009
102	144.2	192.2	320.4	773.1	1950
103	140.1	186.8	311.3	752.3	1894
104	136.1	181.5	302.5	732.1	1840
105	132.3	176.4	294.0	712.6	1788
106	128.6	171.4	285.7	693.6	1737
107	125.0	166.7	277.8	675.3	1688
108	121.6	162.0	270.1	657.5	1640
109	118.2	157.6	262.6	640.3	1594
+110	115.0	153.2	255.4	623.5	1550
111	111.8	149.0	248.4	607.3	1507
112	108.8	145.0	241.6	591.6	1465
113	105.8	141.1	235.1	576.4	1425
114	103.0	137.2	228.7	561.6	1386
115	100.2	133.6	222.6	547.3	1348
116	97.6	130.0	216.7	533.4	1311
117	95.0	126.5	210.9	519.9	1276
118	92.5	123.2	205.3	506.8	1241
119	90.0	119.9	199.9	494.1	1208
+120	87.7	116.8	194.7	481.8	1176
121	85.4	113.8	189.6	469.8	1145
122	83.2	110.8	184.7	458.2	1114
123	71.1	107.9	179.9	446.9	1085
124	79.0	105.2	175.3	435.9	1057
125	77.0	102.5	170.8	425.3	1029
126	75.0	99.9	166.4	414.9	1002
127	73.1	97.3	162.2	404.9	976.3
128	71.3	94.9	158.1	395.1	951.1
129	69.5	92.5	154.1	385.6	926.7
+130	67.8	90.2	150.3	376.4	903.0
131	66.1	87.9	146.5	367.4	880.0
132	64.4	85.7	142.9	358.7	857.7
133	62.9	83.6	139.4	350.3	836.1
134	61.3	81.6	136.0	342.0	815.0
135	59.8	79.6	132.6	334.0	794.6
136	58.4	77.6	129.4	326.3	774.8
137	57.0	75.8	126.3	318.7	755.6
138	55.6	73.9	123.2	311.3	736.9
139	54.3	72.2	120.3	304.2	718.8
+140	53.0	70.4	117.4	297.2	701.2
141	51.7	68.8	114.6	290.4	684.1
142	50.5	67.1	111.9	283.8	667.5
143	49.3	65.5	109.2	277.4	651.3
144	48.2	64.0	106.7	271.2	635.6
145	47.0	62.5	104.2	265.1	620.3
146	45.9	61.1	101.8	259.2	605.5
147	44.9	59.6	99.40	253.4	591.1
148	43.8	58.3	97.10	247.8	577.1
149	42.8	56.9	94.87	242.3	563.5
+150	41.9	55.6	92.70	237.0	550.2

Note: Data in beige refer to thermistors with ±0.2°C interchangeability.
Data in white refer to thermistors with ±0.1°C interchangeability.
Temperature /resistance figures are the same for both types.

Note: Only thermistors with ±0.2°C interchangeability are available encased in Teflon as standard parts. For Part No. of Teflon encased thermistors add 100 to part No. of ±0.2°C interchangeable thermistors. Example: 44005 is a standard thermistor. 44105 is a Teflon encased thermistor with the same resistance values.

TABLE XXI

Resistance Vs Temperature for Series "700" Linear Thermistors

These tables give the resistance values for T1 and T2 as defined on Page F-10 for the 44018 Linear Response Thermistor which is used in the Series 700 Linear Thermistor Probes. Resistance in ohms. Temperature in °C.

T_1 RESISTANCE VERSUS TEMPERATURE −30 TO +100°C

TEMP°C	RES	TEMP°C	RES	TEMP°C	RES	TEMP°C	RES	TEMP°C	RES
−30	106.2K	0	19.59K	+30	4834	+60	1493	+90	549.8
29	99.82K	+ 1	18.62K	31	4634	61	1440	91	533.2
28	93.88K	2	17.70K	32	4442	62	1389	92	517.2
27	88.32K	3	16.83K	33	4260	63	1341	93	501.8
26	83.12K	4	16.01K	34	4084	64	1294	94	486.8
25	78.26K	5	15.24K	35	3918	65	1249	95	472.4
24	73.72K	6	14.50K	36	3760	66	1207	96	458.6
23	69.46K	7	13.81K	37	3610	67	1165	97	445.2
22	65.48K	8	13.15K	38	3466	68	1126	98	432.2
21	61.74K	9	12.53K	39	3328	69	1087	99	419.6
−20	58.26K	+10	11.94K	+40	3196	+70	1051	+100	407.6
19	54.98K	11	11.38K	41	3070	71	1016		
18	51.90K	12	10.85K	42	2950	72	981.8		
17	49.02K	13	10.35K	43	2836	73	949.4		
16	46.32K	14	9878	44	2726	74	918.0		
15	43.78K	15	9428	45	2620	75	888.0		
14	41.40K	16	9000	46	2520	76	859.0		
13	39.16K	17	8594	47	2424	77	831.2		
12	37.04K	18	8210	48	2334	78	804.4		
11	35.06K	19	7844	49	2246	79	773.6		
−10	33.20K	+20	7496	+50	2162	+80	753.8		
9	31.49K	21	7166	51	2080	81	729.8		
8	29.80K	22	6852	52	2004	82	706.8		
7	28.24K	23	6554	53	1930	83	684.4		
6	26.78K	24	6270	54	1859	84	663.0		
5	25.40K	25	6000	55	1792	85	642.4		
4	24.10K	26	5744	56	1727	86	622.6		
3	22.88K	27	5500	57	1664	87	603.4		
2	21.72K	28	5266	58	1605	88	584.8		
− 1	20.62K	29	5046	59	1547	89	567.0		

T_2 RESISTANCE VERSUS TEMPERATURE −30 TO +100°C

TEMP°C	RES	TEMP°C	RES	TEMP°C	RES	TEMP°C	RES	TEMP°C	RES
−30	481.0K	0	94.98K	+30	24.27K	+60	7599	+90	2799
29	453.5K	+ 1	90.41K	31	23.28K	61	7332	91	2714
28	427.7K	2	86.09K	32	22.33K	62	7076	92	2632
27	403.5K	3	81.99K	33	21.43K	63	6830	93	2552
26	380.9K	4	78.11K	34	20.57K	64	6594	94	2476
25	359.6K	5	74.44K	35	19.74K	65	6367	95	2402
24	339.6K	6	70.96K	36	18.96K	66	6149	96	2331
23	320.9K	7	67.66K	37	18.21K	67	5940	97	2262
22	303.3K	8	64.53K	38	17.49K	68	5738	98	2195
21	286.7K	9	61.56K	39	16.80K	69	5545	99	2131
−20	271.2K	+10	58.75K	+40	16.15K	+70	5359	+100	2069
19	256.5K	11	56.07K	41	15.52K	71	5180		
18	242.8K	12	53.54K	42	14.92K	72	5007		
17	229.8K	13	51.13K	43	14.35K	73	4842		
16	217.6K	14	48.84K	44	13.80K	74	4682		
15	206.2K	15	46.67K	45	13.28K	75	4529		
14	195.4K	16	44.60K	46	12.77K	76	4381		
13	185.2K	17	42.64K	47	12.29K	77	4239		
12	175.6K	18	40.77K	48	11.83K	78	4102		
11	166.6K	19	38.99K	49	11.39K	79	3970		
−10	158.0K	+20	37.30K	+50	10.97K	+80	3843		
9	150.0K	21	35.70K	51	10.57K	81	3720		
8	142.4K	22	34.17K	52	10.18K	80	3602		
7	135.2K	23	32.71K	53	9807	83	3489		
6	128.5K	24	31.32K	54	9450	84	3379		
5	122.1K	25	30.00K	55	9109	85	3273		
4	116.0K	26	28.74K	56	8781	86	3172		
3	110.3K	27	27.54K	57	8467	87	3073		
2	104.9K	28	26.40K	58	8166	88	2979		
− 1	99.80K	29	25.31K	59	7876	89	2887		

Table of Total Emissivity

These tables are presented for use as a guide when making infrared temperature measurements with the OMEGASCOPE™ or other infrared pyrometers. The total emissivity (ε) for Metals, Non-metals and Common Building Materials are given.

Since the emissivity of a material will vary as a function of temperature and surface finish, the values in these tables should be used only as a guide when making relative or delta measurements.

The exact emissivity of a material should be determined when absolute measurements are required.

METALS

MATERIAL	TEMPERATURE (°F)	ε - EMISSIVITY
Alloys		
20-Ni, 24-CR, 55-FE, Oxidized	392	.90
" " " "	932	.97
60-Ni, 12-CR, 28-FE, Oxidized	518	.89
" " " "	1040	.82
80-Ni, 20-CR, Oxidized	212	.87
" " "	1112	.87
" " "	2372	.89
Aluminum		
Unoxidized	77	.02
"	212	.03
"	932	.06
Oxidized	390	.11
"	1110	.19
Oxidized at 1110°F	390	.11
" " "	1110	.19
Heavily Oxidized	200	.20
" "	940	.31
Highly Polished	212	.09
Roughly "	212	.18
Commercial Sheet	212	.09
Highly Polished Plate	440	.04
" " "	1070	.06
Bright Rolled Plate	338	.04
" " "	932	.05
Alloy A3003, Oxidized	600	.40
" " "	900	.40
Alloy 1100-0	200-800	.05
Alloy 24ST	75	.09
" " Polished	75	.09
Alloy 75ST	75	.11
" " Polished	75	.08
Bismuth, Bright	176	.34
" Unoxidized	77	.05
" "	212	.06
Brass		
73% Cu, 27% Zn, Polished	476	.03
" " "	674	.03
62% Cu, 37% Zn, Polished	494	.03
" " "	710	.04
83% Cu, 17% Zn, Polished	530	.03
Matte	68	.07
Burnished to Brown Color	68	.40
Cu-Zn, Brass Oxidized	392	.61
" " "	752	.60
" " "	1112	.61
Unoxidized	77	.04
"	212	.04
Cadmium	77	.02
Carbon		
Lampblack	77	.95
Unoxidized	77	.81
"	212	.81
"	932	.79
Candle Soot	250.95,	
Filament	500	.95
Graphitized	212	.76
"	572	.75
"	932	.71
Chromium	100	.08
"	1000	.26
" Polished	302	.06
Cobalt, Unoxidized	932	.13
" "	1832	.23
Columbium, Unoxidized	1500	.19
" "	2000	.24
Copper		
Cuprous Oxide	100	.87
" "	500	.83
" "	1000	.77
Black, Oxidized	100	.78
Etched	100	.09
Matte	100	.22
Roughly Polished	100	.07
Polished	100	.03
Highly Polished	100	.02
Rolled	100	.64
Rough	100	.74
Molten	1000	.15
"	1970	.16
"	2230	.13
Nickel Plated	100-500	.37
Dow Metal	0-600	.15
Gold		
Enamel	212	.37
Plate (.0001)		
on .0005 Silver	200-750	.11-.14
on .0005 Nickel	200-750	.07-.09
Polished	100-500	.02
"	1000-2000	.03
Haynes Alloy C, Oxidized	600-2000	.90-.96
Haynes Alloy 25, "	600-2000	86-.89
Haynes Alloy X, "	600-2000	85-.88
Inconel Sheet	1000	.28
" "	1200	.42
" "	1400	.58
Inconel X, Polished	75	.19
Inconel B, "	75	.21
Iron		
Oxidized	212	.74
"	930	.84
"	2190	.89
Unoxidized	212	.05
Red Rust	77	.70
Rusted	77	.65
Liquid	2760-3220	.42-.45
Cast Iron		
Oxidized	390	.64
"	1110	.78
Unoxidized	212	.21
Strong Oxidation	104	.95
" "	482	.95
Liquid	2795	.29
Wrought Iron		
Dull	77	.94
"	660	.94
Smooth	100	.35
Polished	100	.28
Lead		
Polished	100-500	.06-.08
Rough	100	.43
Oxidized	100	.43
Oxidized at 1100°F	100	.63
Gray Oxidized	100	.28
Magnesium	100-500	.07-.13
Magnesium Oxide	1880-3140	.16-.20
Mercury	32	.09
"	77	.10
"	100	.10
"	212	.12
Molybdenum	100	.06
"	500	.08
"	1000	.11
"	2000	.18
" Oxidized at 1000°F	600	.80
" " " "	700	.84
" " " "	800	.84
" " " "	900	.83
" " " "	1000	.82
Monel, Ni-Cu	392	.41
" "	752	.44
" "	1112	.46
" " Oxidized	68	.43
" " Oxidized at 1110°F	.1110	.46
Nickel		
Polished	100	.05
Oxidized	100-500	.31-.46
Unoxidized	77	.05
"	212	.06
"	932	.12
"	1832	.19
Electrolytic	100	.04
"	500	.06
"	1000	.10
"	2000	.16
Nickel Oxide	1000-2000	.59-.86
Palladium Plate		
(.00005 on .0005 silver)	200-750	.16-.17
Platinum	100	.05
"	500	.05
"	1000	.10
" Black	100	.93
" "	500	.96
" "	2000	.97
" Oxidized at 1100°F	500	.07
" " " "	1000	.11
Rhodium Flash		
(.0002 on .0005 Ni)	200-700	.10-.18
Silver		
Plate (.0005 on Ni)	200-700	.06-.07
Polished	100	.01
"	500	.02
"	1000	.03
"	2000	.03
Steel		
Cold Rolled	200	.75-.85
Ground Sheet	1720-2010	.55-.61
Polished Sheet	100	.07
" "	500	.10
" "	1000	.14
Mild Steel, Polished	75	.10
" " Smooth	75	.12
" " Liquid	2910-3270	.28
Steel, Unoxidized	212	.08
" Oxidized	77	.80
Steel Alloys		
Type 301, Polished	75	.27
" " "	450	.57
" " "	1740	.55
" 303, Oxidized	600-2000	.74-.87
" 310, Rolled	1500-2100	.56-.81
" 316, Polished	75	.28
" " "	450	.57
" " "	1740	.66
" 321	200-800	.27-.32
" " Polished	300-1500	.18-.49
" " w/BK Oxide	200-800	.66-.76
" 347, Oxidized	600-2000	.87-.91
" 350	200-800	.18-.27
" " Polished	300-1800	.11-.35
" 446, Polished	300-1500	.15-.37
" 17-7PH	200-600	.44-.51
" " Polished	300-1500	.09-.16
" C1020, Oxidized	600-2000	.87-.91
" PH-15-7 MO	300-1200	.07-.19
Stellite, Polished	68	.18
Tantalum		
Unoxidized	1340	.14
"	2000	.19
"	3600	.26
"	5306	.30
Tin, Unoxidized	77	.04
" "	212	.05
Tinned Iron, Bright	76	.05
" " "	212	.08

Emissivity Table

METALS

MATERIAL	TEMPERATURE (°F)	ϵ - EMISSIVITY
Titanium		
Alloy C110M, Polished	300-1200	.08-.19
" " Oxidized at 1000°F	200-800	.51-.61
" T1-95A, " " "	200-800	.35-.48
Anodized onto SS	200-600	.96-.82
Tungsten		
Unoxidized	77	.02
"	212	.03
"	932	.07
"	1832	.15
"	2732	.23
"	3632	.28
Filament (Aged)	100	.03
" "	1000	.11
" "	5000	.35
Uranium Oxide	1880	.79
Zinc		
Bright Galvanized	100	.23
Commercial 99.1%	500	.05
Galvanized	100	.28
Oxidized	500-1000	.11
Polished	100	.02
"	500	.03
"	1000	.04
"	2000	.06

NON-METALS

MATERIAL	TEMPERATURE (°F)	ϵ - EMISSIVITY
Adobe	68	.90
Asbestos		
Board	100	.96
Cement	32-392	.96
" Red	2500	.67
" White	2500	.65
Cloth	199	.90
Paper	100-700	.93
Slate	68	.97
Asphalt, pavement	100	.93
" tar paper	68	.93
Basalt	68	.72
Brick		
Red, rough	70	.93
Gault Cream	2500-5000	.26-.30
Fire Clay	2500	.75
Light Buff	1000	.80
Lime Clay	2500	.43
Fire Brick	1832	.75-.80
Magnesite, Refractory	1832	.38
Gray Brick	2012	.75
Silica, Glazed	2000	.88
" Unglazed	2000	.80
Sandlime	2500-5000	.59-.63
Carborundum	1850	.92
Ceramic		
Alumina on Inconel	800-2000	.69-.45
Earthenware, Glazed	70	.90
" Matte	70	.93
Greens No. 5210-2C	200-750	.89-.82
Coating No. C20A	200-750	.73-.67
Porcelain	72	.92
White Al_2O_3	200	.90
Zirconia on Inconel	800-2000	.62-.45
Clay	68	.39
" Fired	158	.91
" Shale	68	.69
" Tiles, Light Red	2500-5000	.32-.34
" " Red	2500-5000	.40-.51
" " Dark Purple	2500-5000	.78
Concrete		
Rough	32-2000	.94
Tiles, Natural	2500-5000	.63-.62
" Brown	2500-5000	.87-.83
" Black	2500-5000	.94-.91
Cotton Cloth	68	.77
Dolomite Lime	68	.41
Emery Corundum	176	.86
Glass		
Convex D	212	.80
" "	600	.80
" "	932	.76
Nonex	212	.82
"	600	.82
"	932	.78
Smooth	32-200	.92-.94
Granite	70	.45
Gravel	100	.28
Gypsum	68	.80-.90
Ice, Smooth	32	.97
" Rough	32	.98
Lacquer		
Black	200	.96
Blue, on Aluminum Foil	100	.78
Clear, " " " (2 coats)	200	.08 (.09)
" on Bright Copper	200	.66
" on Tarnished Copper	200	.64
Red, on Aluminum Foil (2 coats)	100	.61 (.74)
White	200	.95
White, on Aluminum Foil (2 coats)	100	.69 (.88)
Yellow, " " " "	100	.57 (.79)
Lime Mortar	100-500	.90-.92
Limestone	100	.95
Marble, White	100	.95
" Smooth, White	100	.56
" Polished Gray	100	.75
Mica	100	.75
Oil on Nickel		
.001 Film	72	.27
.002 "	72	.46
.005 "	72	.72
Thick "	72	.82
Oil, Linseed		
On Aluminum Foil, uncoated	250	.09
" " " 1 coat	250	.56
" " " 2 coats	250	.51
On Polished Iron, .001 Film	100	.22
" " " .002 "	100	.45
" " " .004 "	100	.65
" " " Thick Film	100	.83
Paints		
Blue, CU_2O_3	75	.94
Black, CuO	75	.96
Green, CU_2O_3	75	.92
Red, Fe_2O_3	75	.91
White, Al_2O_3	75	.94
" Y_2O_3	75	.90
" ZnO	75	.95
" $MgCO_3$	75	.91
" ZrO_2	75	.95
" ThO_2	75	.90
" MgO	75	.91
" $PbCO_3$	75	.93
Yellow, PbO	75	.90
" $PBCrO_4$	75	.93
Paints, Aluminum	100	.27-.67
10% Al	100	.52
26% Al	100	.30
Dow XP-310	200	.22
Paints, Bronze	Low	.34-.80
Gum Varnish (2 coats)	70	.53
" " (3 coats)	70	.50
Cellulose Binder (2 coats)	70	.34
Paints, Oil		
All colors	200	.92-.96
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" 6.88 mm	540	.93
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Surface	100	.38
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An OMEGA Group Company
P.O. Box 4047
One Omega Drive
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